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DATES OF PUBLICATION AND NUMBERS OF PAST VOLUMES OF THE TRANSACTIONS AND PROCEEDINGS OF THE ENTOMOLOGICAL SOCIETY OF LONDON

In view of the new form and manner of issue of the Transactions and Proceedings of the Society, which commence with the issues for the year 1926, it seems advisable to call attention to the dates of issue and to the volume numbers borne by past volumes.

It will be noticed that the accompanying volume is numbered Part I of Volume 74. A glance at the table below will show how this number has been calculated.

During the years 1807, 1809 and 1812, Parts 1, 2 and 3 respectively of Vol. I of the Transactions of the Entomological Society of London were issued. The Society which published this Volume, however, although a forerunner of the present Society, was by no means its parent, and therefore its publication (only the one volume was ever issued) has not been included in our series. This commenced in 1834.

New Vol Nos	Old Vol Nos	DATES OF ISSUE OF PARTS										
		Pt. 1	Pt 2	Pt. 3	Pt 4	Pt 5	Pt. 6	Pt. 7	Pt 8	Pt. 9	Pt. 10	Pt. 11
1	1	1834	1835	1836	—	—	—	—	—	—	—	—
2	2	1837	1838	1839	1840	—	—	—	—	—	—	—
3	3	1841	1842	1842	1843	—	—	—	—	—	—	—
4	4	1845	1845	1846	1847	1847	—	—	—	—	—	—
5	5	1847	1847	1848	1848	1848	1849	1849	1849	1850	—	—
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6	1	1850	1850	1850	1851	1851	1851	1851	1852	—	—	—
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14	4	1865	1867	1867	1868	1868	—	—	—	—	—	—
15	5	1865	1866	1866	1866	1867	1867	1867	—	—	—	—
74	—	1926	—	—	—	—	—	—	—	—	—	—

After the issue of Vol 5 of the Third Series, the Volumes ceased to be numbered. Thereafter, until 1925, the Transactions and Proceedings have been issued jointly, usually in 5 parts, one volume for each year, some of the parts being issued in the year to which they belong, others in the succeeding year.

In order to overcome the difficulties resulting from this system the Council has decided that, commencing with the year 1926, the Transactions and the Proceedings will be issued as separate Volumes and shall be numbered. Since the completion of Vol. 5 of Series III fifty-eight volumes have been issued. The Volume of the Transactions for 1926 therefore becomes Vol. 74; the Volume of the Proceedings, however, will be known as Volume I.

The Transactions will consist of two parts only, and it is hoped that both will be issued during the year to which they belong. Of the Proceedings three parts will be issued, the third, containing the report of the Annual Meeting and the Presidential Address, being necessarily published in the year following that with which it deals.

INSTRUCTIONS TO AUTHORS

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TRANSACTIONS

OF THE

ENTOMOLOGICAL SOCIETY

OF LONDON

VOL. 74.* 1926.

MONOGRAPH OF THE TRIBE HESPERIIDI (EUROPEAN SPECIES) WITH REVISED CLASSIFICATION OF THE SUBFAMILY HESPERIINAE (PALÀEARCTIC SPECIES) BASED ON THE GENITAL ARMATURE OF THE MALES

By B. C. S. WARREN.

[Read April 7th, 1926.]

PLATES I–LX AND TWO TEXT-FIGURES.

CONTENTS.

* For explanation of this number see leaflet.

I. Introduction.

In 1910, the first of Prof. Reverdin's papers, which were to revolutionise our knowledge of the Hesperids, appeared in the *Bulletin de la Société lépidoptérologique de Genève*, to be followed almost yearly by further papers; and ever since that date, in the light of those papers, it has been more and more evident how completely useless, not to say misleading, all the existing systematic works on the Palaearctic Hesperids were. The need of some such work as the present was becoming yearly greater, and most European entomologists were expecting that Prof. Reverdin would sooner or later fill this gap in entomological literature himself. But unfortunately it was not to be so. Some years ago the Professor informed me that he no longer felt his health equal to beginning such an arduous piece of work, at the same time suggesting that I should undertake it. That my capabilities were thus highly rated in his estimation, led me to agree to do so; and I can only hope that the student or collector, who may turn to this work for help, will not put it down feeling that the Professor's confidence was altogether misplaced.

A word of explanation is necessary on one or two points. First, the short and very fragmentary distribution lists in the systematic part. Owing to the past confusion in identifying Hesperid species the published data as to localities for the various species are entirely unreliable, and as complete accuracy was not only desirable, but, one may say, absolutely essential, it was felt preferable to reduce the lists to those records which were *proved correct*. With this object in view I have personally examined specimens from every locality recorded, excepting those vouched for by Prof. Reverdin, the Rev. G. Wheeler, Dr. Verity and M. Oberthür. I may add that, in all cases of difficulty, Dr. Verity submitted specimens to Prof. Reverdin for identification, and subsequently worked on the information thus acquired, so that we can accept his records of the distribution of Italian species without question; while of M. Oberthür's records, only those about which there could be no question have been included. In the distribution lists, the name after the locality is in most cases that of the captor of the insect. But in the case of Prof. Reverdin, it means that he has identified the insect, which he may have caught himself, or have received from some other source. The Professor has received such quantities of specimens from collectors in European and foreign countries, that it was quite impracticable, and often impossible, to add the name of the captor in each case. The same applies to localities followed by (*Chapman coll.*) as distinct from (*Chapman*); the former implies the captor to be unknown, the latter that the insect was taken by the late Dr. Chapman himself. The same, of course, applies to those records followed by (*British Museum coll.*), etc.

Second, it is quite impossible to study the Hesperids for long without realising that much of the similarity between distinct species is probably due to mimicry. Several very remarkable instances occur, and at one time I had contemplated the inclusion of a short essay on the subject. On consideration, however, it seemed that this might be out of place in such a work as the present. It was not possible, however, to avoid touching on it altogether; so remarks on some of the most interesting cases will be found scattered through the work. For the benefit of those interested in the subject, I mention these cases here, so as to enable them to be found :—*P. geron*, etc., in Part IV, p. 23; *T. tessellum* mimicking *F. cribrellum* in Part VII, p. 40; *H. sidae* and *R. antonia* under *H. sidae* (Part X, pp. 61, 62).

Third, of the plates illustrating the insects themselves a word must be said. They were essentially intended to be useful, to assist in the correct identification of specimens, and to supplement descriptions of forms which although appearing fairly distinct to the eye do not lend themselves to really concise description. The carrying-out of this purpose necessitated in many instances the use of damaged specimens, or those which had been dissected for anatomical examination, for although they were not perfect specimens they showed some desired peculiarity. The plates, therefore, from an artistic point of view, are far from perfect; but they have the merit of being absolutely accurate, and the reader may place complete confidence in what he sees in them. Nearly all the principal subspecies and races as well as numerous aberrations have been illustrated, and illustrated when possible by several specimens, which conveys the characteristic appearance of a race in a clear manner absolutely unobtainable by the representation of single specimens. It was felt that this would be of greater value in the eyes of the reader than more artistically perfect productions which failed to give him the information he hoped to get from them.

It but remains for me now to acknowledge the generous help I have received from many quarters. To Prof. Reverdin I owe so much that it becomes very difficult to find words to express it. The reader must remember that, but for the Professor's work in past years, the writing of this memoir would never have been possible. Apart from this, he gave me all his MS. notes to make what use I liked of; while, all the time I have been engaged on this work, I have been continually corresponding with him, and he has never failed to answer all my multitudinous questions with the greatest care, and in the most complete detail, always willingly giving me to the fullest extent the benefit of his unequalled experience. Further, I am indebted to him for practically all the very perfect photographs of the genitalia, for with a few exceptions they were all given by him especially for this work; and, finally, I am indebted to him for the loan of numerous interesting specimens, including his type specimens of *H. sibirica*. For all this invaluable help I offer my sincerest thanks, and I trust that this memoir will serve to remind all who may read it of the great advance in our knowledge of the Hesperids that has been brought about by Prof. Reverdin's work during the last sixteen years.

To the late Dr. T. A. Chapman, F.R.S., I am also much indebted. Shortly before his death he gave me permission to reproduce the diagram on Plate I (fig. 1) and his explanation of it; both of which had been published in the *Entomologist's Record* of 1917. For permission to carry this out my thanks are also due to the Editors of that magazine. Dr. Chapman had made a great number of mounts of the genitalia of the Palaearctic Hesperids, and had taken extensive notes on the variations he had observed. These notes he placed at my disposal, though unfortunately he did not live to complete them. After his death the Misses Chapman gave me his entire collection of Palaearctic Hesperids, which has been of the greatest value to me and for which I offer sincere thanks.

My best thanks are also due: to Prof. E. B. Poulton, F.R.S., for the loan of specimens from the Oxford University Museum, with permission to dissect, and a generous offer of a type specimen; to Mr. G. T. Bethune-Baker for help on questions of nomenclature and for the loan of specimens with permission to dissect any or all of them; to Mr. H. Powell for much useful information on the species of North Africa; to Capt. N. D. Riley for help given to me when working the material in the British Museum coll. and for copies of original descriptions, and especially for the greatest assistance in compiling the list

of references to original descriptions, which is given in Part XIII; to the Rev. G. Wheeler, Signor O. Querci, Prof. de Sagarra, Mr. W. G. Sheldon, for distribution lists, and the latter also for looking up original descriptions for me.

II. Morphology of the Male Genital Armature in Hesperid Species.

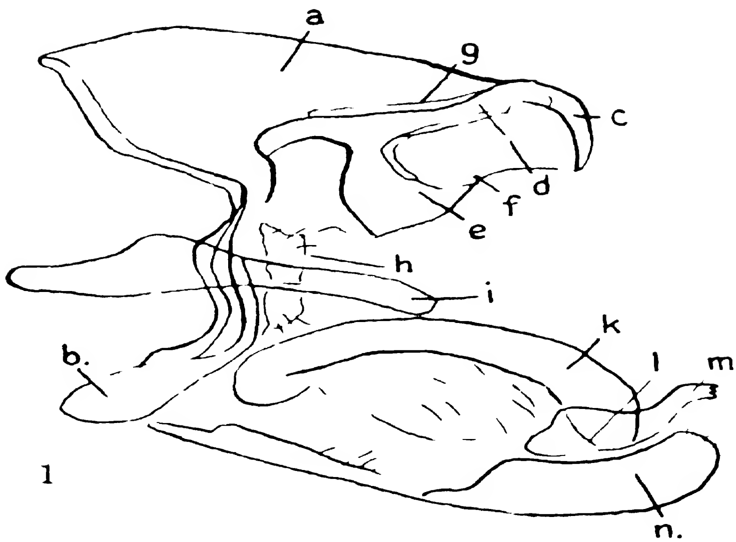
As the classification employed in this work rests on the morphological characters of the male genital armature, and the subdivision of genera and the identification of species is based on the same anatomical foundation, it is necessary, for the benefit of lepidopterists who have not hitherto troubled to study this branch of entomology, to give a description of the Hesperid male armature and the nomenclature employed for the various anatomical processes which go to compose the whole structure.

The following description of the armature of *Hesperia carthami* serves as an excellent introduction to the subject.

" *Hesperia carthami* may be assumed to be the species with the least specialised armature. Assumed, because though there are reasons for the assumption, they cannot claim to be in any way proofs, and there may be various considerations to the contrary. The most definite ground for regarding this form as more primitive is the structure of the ventral plate of the 10th abdominal segment. This plate, in the Hesperias, is solidly soldered to the dorsal portion of the segment. In *carthami* it is a simple plate (armed with rough points) forming, with the dorsal portion of the segment, a ring. [For the following compare Pl. I, fig. 1.]

" *a*. The Tegmen (tergite); *b*. the Saccus (sternite), with the connecting lines of chitin form the ring of the 9th abdominal segment; *c*. the Uncus; *d*. the connecting portion; and *e*. the 10th Sternite, forming together the ring of the 10th abdominal segment. *f*. refers to the membranous floor of the genital cavity, or that portion of it closing the 10th segment, extending from the 10th sternite to the tip of the uncus (tergite). This membrane is frequently lost in preparing the specimen, but in a considerable number it is more or less preserved. This portion is pierced by the Anus (not shown in diagram), it would be near the point marked by *f*. The rest of the floor of the genital cavity extends from the posterior margin of the 10th sternite to the bases of the clasps (and, of course, laterally to the ring of the 9th segment), it is pierced by the Aedoeagus, *i*, and is membranous for the most part, but has in many species, as in *Hesperia*, a circle of chitinous material, *h*, surrounding the exit of the aedoeagus, which may best be called the Penis-sheath, a name to which it is probably entitled by priority.

" In the diagram is a suture marked *g*, quite evident also in the photograph (Pl. XV, fig. 6), and to be made out in preparations of many species of *Hesperia*, this is the suture between the 9th and 10th segments. It will be noted that it marks off from the tegmen a portion that is not 9th but 10th segment, and that the dorsal portion of the 10th segment is not merely the uncus, but also a portion of what we have been used to accepting as the solid indivisible 9th tergite. At its anterior termination it may be regarded as opening out into the membranous intersegmental membrane (floor of genital cavity) uniting (or separating) the 9th and 10th segments laterally and ventrally. The Claspers are rather complicated organs, but are divisible, as is very usual, into a lower (ventral) section, the Valve, *n*, and an upper (or more dorsal) section, the Harpe, *k*, *l*, *m*. The clasp is a combination of two apophyses of the ventral aspect of the 9th segment, which it is desirable to distinguish by



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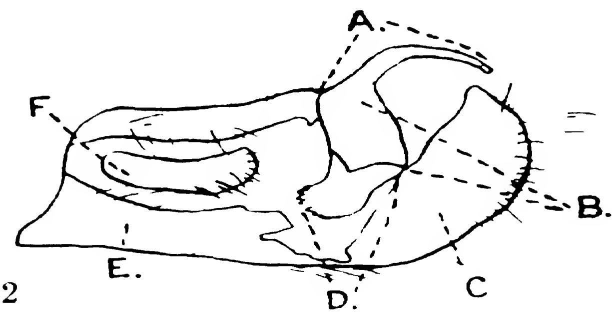

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Diagrams of male armatures of *Hesperia*

1 *H carthami*

a Tegmen *b* Saccus *c* Uncus *d* Connecting portion *e* 10th sternite *f* Membrane closing 10th segment *g* Suture between 9th and 10th segments *h* Penis sheath *i* Aedoeagus *k* Harpe *l* Stylifer *m* Style *n* Cuiller

2 *H fritillum*

a Style *b* Stylifer *c* Cuiller *d* Antistyle *e* Ventral Plate *f* Subharpal Plate

separate names, and for these 'valve' and 'harpe' seem available, though much confusion has arisen from ignoring the term 'harpe' and using the terms 'valve' and 'clasp' synonymously. In some groups, as in Pierids, the valve is well developed, but it is difficult to say that the harpe is discoverable, in such a case the terms valve and clasp are practically synonymous.

"In *Hesperia* the harpe is rather elaborate, it consists of a basal portion, *k*, which, at the line, *l*, folds over (or appears to) and forms what looks like another separate piece, this again terminates in a further process, *m*, called by Rambur the STYLE, which differs considerably in different species. Dr. Reverdin appears to extend the term style to include the whole plate that looks like a separate piece, but is attached to the basal portion, *k*, at the line, *l*. He uses the term 'CUILLER' (spoon) for the terminal portion of the valve, indicated in the diagram by *n*, which has in many species a very spoon-like aspect." (*Chapman.*)

The following note was added at the end of the paper, which was not published until 1919.

"I have felt a want of names for the curious separate-looking portion of the clasp that carries the style (Rambur), and for its basal projection, I think suitable names would be the stylifer and the antistyle."

In Pl. I, fig. 2, the lines diverging from *b*, show the STYLIFER, and those from *d*, the ANTISTYLE.

The reader, although he may previously have taken no interest in insect anatomy, will be enabled by this excellent account easily to follow the various descriptions, given in this work, of the generic, subgeneric, and specific characters. It will, however, be necessary to consider the construction of these organs in greater detail, and especially the process called the style; for there appears to have been a certain amount of inaccuracy in the determination of what constitutes the style, and, also, that process is of a far more complicated nature than would be supposed.

To start with, the whole clasp must be considered. It has been known for long that the structure along the dorsal aspect of the clasp, called the harpe, is a development on the inside of the clasp; but the full meaning of this does not appear to have been recognised, for, if it were, the term "valve" could not have continued to be used in the sense in which it is at present. Chapman remarks that much confusion has arisen from using the terms "valve" and "clasp" synonymously, but goes on to say, "In some groups . . . it is difficult to say that the harpe is discoverable, in such a case the terms 'valve' and 'clasp' are practically synonymous."

In the Hesperids, in spite of the fact that the harpe is often highly developed, these terms, as at present understood, can only be considered to be synonymous; for if the harpe be removed (a perfectly simple matter) the outline and general form of the clasp remains quite unaltered. Then, too, in the HESPERIINAE some species are practically without a harpe. To call the lateral apophyses of the 9th sternite "valves" in these species and "clasps" in all others, although the structures are absolutely homologous, only a little less fully developed in the former, demonstrates that the terms "valve" and "clasp," as at present used, are indistinguishable quantities.

At present the clasp is treated as though it were a structure divided horizontally into two parts, the "valve" which represents the ventral portion, and the harpe which represents the dorsal. If we remove the so-called "valve," there remains nothing but a small fragment of the clasp, obviously just a unit of the whole; but, if we remove that unit, the whole (*i.e.* clasp) remains

unchanged in size or form, unquestionably still the whole, but now called the "valve." One might as well propose to use a different name for the leg of an insect when the claws were removed from the foot and when they were in position. Further, when one removes the harpe, it becomes impossible to limit the term "valve" to the ventral portion which it appeared to represent when the harpe was present, for it is seen that the ventral portion is a solid part of the structure which underlies the harpe; and it would, without question, be an absurdity to try to give a name to this dorsal part when it is absolutely indivisible from the ventral section. When the harpe is present the circumstances are, of course, exactly the same; for the name "harpe" applies to the inner dorsal structure and not to the surface underlying it, which is a quite distinct object. The true explanation of all this confusion is, that the term "valve," as at present used, stands for a process which is only apparent and not real, there being no real horizontal division of the clasps. The true division is *vertical*, the clasps being structures of a double nature, and the cause of our trouble with the terms "valve" and "clasp" is to be found in the failure to recognise that the harpe, as an inner structure, does not stand alone.

The genitalia are supposed to have developed from an amalgamation of the outer and inner body-tubes of the insect, and certain structures are considered to be essentially connected with the outer and others with the inner body-tube. In this manner the clasp is always cited in the former category, but I have little doubt that the duplication of structure we see in that process is an indication of its double derivation, and that the inner elements of the clasp are developed from the inner body-tube, and are, as such, distinct structures which cannot be included with parts of the outer structure, just because, when looked at through the microscope or lens, the vertical separation is invisible. The invisibility, however, does not make it any the more correct to cover with one name two incomplete portions of two separate structures.

A more exact description of the structure of the whole clasp will demonstrate the position more clearly.

The clasp is composed of two chitinous sheets, standing side by side, united round their edges one to the other; the outer one being complete, the inner one incomplete and only partially represented. The outer sheet exhibits the complete outline of the structure; the inner one in many species is also complete in outline, but not always; and its central area is always deficient, to a greater or less extent. It is this failure of the central parts that creates the harpe, for were the sheet complete, that process would be non-existent. It is the same with the cuiller, which varies in size according to the amount of the inner sheet present. In the central area, that is the area below the harpe and above such ventral portions of the inner sheet as are present, there is usually a small fragment of the inner sheet remaining, which varies considerably in size, form, and position. This piece I shall call the SUBHARPAL PLATE. In certain instances it is of great value in the separation of species, though it has so far not been noticed by any authority on the Hesperids. The ventral strip of the inner sheet, which connects with the cuiller, may be suitably called the VENTRAL PLATE. These parts can be clearly seen on diagram 2 (Pl. I), *F*. subharpal plate; *E*. ventral plate; *C*. cuiller; *A*. style; *B*. stylifer; *D*. antistyle.

I have already mentioned that it is possible to remove the harpe from the clasp. That is merely the result of separating the inner and outer sheets, or, rather, that small portion of the inner sheet which composes the harpe, from the outer. Similarly, it is possible to remove any of the other parts of the inner sheet from the outer. In the case of the cuiller, when that process is very

1

2

Structure of clasp in *Hesperia*.

1. *H. sidae*.

Right clasp with primary and secondary semiclasps separated but still connected along the dorsal edge of the cuiller.

2. *H. cacaliae*.

Left clasp, with primary and secondary semiclasps separated, but still connected along the dorsal edge of the harpe. (Both × 30.)

narrow at its proximal end, it requires considerable skill to separate the two sheets without breaking them; but in species in which it is wider, it is much less difficult. I have succeeded in some cases in separating the two sheets in their entirety without dislocating the various portions of the inner sheet. This is possible because these various parts (harpe, subharpal plate, ventral plate, and cuiller) are connected by an extremely thin membrane, or, rather, are developments of that membrane. The connecting portions of the membrane are invisible in mounted specimens; but, if unbroken, retain the whole inner structure in natural position when the inner sheet is taken from the outer.

The two sheets are connected all round their dorsal, distal, and ventral edges, but not at the proximal end, where the outer is connected to the sternal portions of the ring of the 9th segment; while the inner (which at its extreme proximal end is always entirely unchitinised and purely membranous) is one with the internal membrane, which composes the floor of the genital cavity. Apart from the fusion round their three extreme edges the two sheets are absolutely free from each other. The photographs on Plate II illustrate this double structure more clearly than any description: fig. 1 shows the right clasp of *H. sidae* with the inner and outer sheets separated, but still connected along the dorsal edge of the cuiller, viewed from the interior of both sheets; fig. 2 shows an example of *H. cacaliae* mounted in the same manner.

It will be seen, therefore, that the clasp is a combination of two apophyses of the 9th sternite, not dorsally and ventrally opposed one to the other (as is commonly accepted), but laterally. This being so, it is obvious that both the dorsal and ventral aspects, as such, are not separable units.

The various formations to be seen in the palaearctic species strongly suggest that originally the inner sheet was complete; for almost every portion of unchitinised membrane to be seen in a given species can be found chitinised in other species. Sometimes the harpe and subharpal plate are one, sometimes the latter and the ventral plate are united, and the latter is always more or less united to the cuiller, sometimes very broadly united. In the case of certain American species the ventral plate and cuiller form one solid piece covering the entire ventral half of the clasp. In such cases there cannot be said to be any ventral plate. All this suggests that these various parts were all once united, especially when we remember that they are developed on a common foundation. In some cases it is possible to remove the ventral plate, or even the cuiller (when it is small as in *P. sertorius*), by catching the membrane in a forceps and gently peeling it off.

The question of nomenclature, viewed in the light of the above remarks, becomes less confusing. The term "valve," with its uncertain meanings and past record of mistaken application, is best forgotten. The term "clasp" remains to cover the whole structure: a combination of two apophyses of the 9th sternite, which apophyses cannot be better designated than as the "primary" and "secondary" semiclasps. The secondary semiclasp is the outer complete one, and the primary semiclasp the inner incomplete one. These names have been chosen in accordance with a very practical suggestion made by a writer in the *Entomologist's Record* some years ago. He proposed that all parts of the genitalia which have originated from the outer cylindrical body-tube should be known as secondary, and those which have been derived from the inner (intestinal) cylindrical body-tube as primary.

It is, of course, difficult, perhaps almost impossible, to decide with certainty whether the primary semiclasp has originated solely from internal elements; but once it is fully understood how entirely distinct and separate the two

semiclasps are, and what extensive changes must have taken place in the inner one to have produced the numerous formations now prevailing, while the outer one has (apparently) remained unaltered, it will be seen that the two must, almost certainly, have developed more or less independently, and therefore most probably from different sources. Added to this, we have the fact that, as previously stated, the secondary semiclasp is attached to, and apparently an extension from, the ring of the 9th abdominal segment; while the primary semiclasp is continuous with the internal membrane.

Considering these facts, I think one is justified in assuming the primary semiclasp to have originated from internal elements. The strength and thickness of some of the chitinous parts of the primary semiclasp might be thought by some to be opposed to the theory of internal origin, but I do not think this is so. Other parts of undoubted internal origin are just as strongly chitinised; as, for instance, the aedoeagus and the penis-sheath, and the extraordinary lateral processes sometimes developed on the latter. Further, the penis-sheath is entirely maintained in position by, and developed on, the internal membrane, just as are the units of the primary semiclasp; and the removal of the clasp, and consequent tearing of the membrane, often fractures the penis-sheath and brings a part of it away attached to the primary semiclasp.

We have, therefore, the "clasp," which stands for the whole process, regardless of whether the harpe is present or not. The primary and secondary semiclasps also represent definite objects, the same in each and every group of species, the fact that their component parts are variable not altering their identity.

The term "cuiller," and what exactly it stands for, requires a word of explanation. The name was given by Reverdin to the terminal process of the clasp, which is often somewhat separated from the more proximal parts. This partial separation gives the false impression that the cuiller is a structure composed of the distal and ventral elements of both semiclasps, which of course is not the case. The cuiller, just as the harpe, is a part of the primary semiclasp.

We may now turn to the question of the style. The name, given by Rambur, appears to have been more or less restricted by use to the slender process extending from the termination of the harpe. This process is really an extension of that part which Chapman called the stylifer, and described as looking as if it were a folded-over piece of the harpe, and also as having the appearance of being a separate plate. In describing some of these structures it is most essential to have this name "stylifer," as also the name "antistyle," applied to the lower portion of the stylifer. In spite of this, it is a fact that there is no such anatomical unit as the stylifer; for what is so called is actually only a solid portion of the harpe, an increase of thickness, as it were, in the terminal area of the harpe. That increase of thickness is on the upper or exterior surface of the harpe (*i.e.* the surface which is not next to the secondary semiclasp), where it assumes the appearance of a plate, sometimes, roughly speaking, square, usually with four angles. From the upper of these extends the style; from the lower, the antistyle; the distal one (attached to the cuiller) and the proximal one, apparently free. At the distal angle and margin, and the whole of the central area, this so-called plate and the harpe are one solid and indivisible piece. At the proximal margin the thickening, which has been gradually expanding above the plane of the surface of the harpe, ceases abruptly, thus producing the free edge of the plate. From the upper angle, or margin, the style rises, and in some species (especially those of the *centaureae* group) the

basal portion of the style often lies over, or against, the side of the harpe before passing the dorsal edge of that structure. In these cases the style is not united to this underlying part of the harpe. The antistyle originates under similar circumstances from the lower aspect of the supposed plate. It will be seen from this that it is the bases of the style and antistyle, and the free proximal edge, which combine to produce the false appearance of the existence of a stylifer. Take away the style and antistyle, and all that meets the eye is the solid termination of the harpe, in which the extra thickness becomes scarcely noticeable. It is, however, possible to remove the style, stylifer, and antistyle from the harpe in one piece, as they really are, when one sees that there is nothing left of the terminal part of the harpe but the slight fragment which has backed the style and (sometimes) extended distally beyond the stylifer. This remnant shows more clearly than anything else how the stylifer is, in reality, not a superimposed plate resting on the groundwork of the harpe, but simply that groundwork itself. Another factor which helps to convey the impression that the stylifer is an additional piece to the main body of the harpe is, that in mounted specimens one sometimes sees through the base of the style a line, continuous with the dorsal line of the harpe, running down to the base of the antistyle. In our photograph of the genitalia of *H. carlinae* (Pl. XXXI, fig. 1) this line can be clearly seen, and it has the appearance of being the edge of the harpe curving down to the antistyle, underneath the stylifer. In reality, however, it is no such thing. In the photograph, immediately after the dorsal edge of the harpe passes behind the base of the style, one sees a very small dark space, roughly triangular, but with its ventral outline strongly concave, of similar density to the antistyle. That space represents all that there is of the harpe behind the style; the whole of the rest of the lighter-coloured area down to the antistyle is solid stylifer, and if the style and stylifer were removed the harpe would be seen to end at the small, dark, triangular space. The line which curves down to the antistyle is merely the edge of the secondary semiclasp. In the highly magnified photographs of the clasps of *carlinae* and *fritillum* (Pl. XXXI, figs. 3 and 4) the termination of the harpe can be very clearly seen, the outer line of the secondary semiclasp being invisible, as it was not in the same plane of focus.

The fact, however, that if one splits the style and antistyle off the harpe, they (if not broken) always bring the stylifer with them, and usually leave the small dorsal fragment of the harpe behind, seems to justify the retention of the name "stylifer" for convenience' sake; although, in a strict sense, such a structure cannot be said to exist. I may add that Chapman was aware of this when he adopted the name.

As already noted, the style is an extension of the stylifer above and beyond the dorsal ridge of the harpe, usually diminishing very rapidly in width directly on clearing the harpe, thus assuming the characteristic appearance which has become associated with the name "style." But, in many species, instead of this recognised formation, we see a broad and very short process extending only slightly beyond the harpe. Such species are regarded by some anatomists as not possessing a style, which is a mistake; for both forms are absolutely homologous processes. The diagnosis of what constitutes a style may be best expressed as follows: any process developed from the stylifer, either distally or dorsally, to, or beyond, the edge of the harpe, of any form or dimension.

According to the idea that the style was merely the fine spine-like part of the process, in many species, such as *serratulae* and *fritillum*, we should have to maintain that the style originated some way above the harpe, and that the

broad basal portion projecting above the harpe constituted something else. That position is absolutely untenable, there being no ground whatever for separating the spine-like portion from its base, both being one piece, which originates where the base passes into the solid terminal portion of the harpe, *i.e.* the stylifer. (See note on position of stylifer, etc., under *F. cribrellum*, Part X, p. 159.)

In conclusion, I would strongly recommend all who are interested in the HESPERIINAE to study the genitalia themselves.

III. CLASSIFICATION.

The general classification of the "Skippers," as a whole, was very exhaustively worked out by Tutt, in his *British Lepidoptera*, vol. viii. It is therefore not necessary to give here more than a summary of his work, so far as the primary divisions are concerned.

He adopts the superfamily name of Urbicolides, and divides this into three families: HESPERIIDAE, URBICOLIDAE and ISMENIDAE. We are only interested in the first of these. This he divides into two subfamilies: PHOCIDINAE and HESPERIINAE, the latter including all the species with which we are concerned. In this subfamily (HESPERIINAE) Tutt classes the species in three tribes: Nisoniadidi, Erynnidi and Hesperiidi. These tribes were diagnosed by Watson in 1893 (*Proc. Zool. Soc. London*), who treated them as genera. Anyone who tries to study the units composing these divisions will realise, very quickly, how utterly impossible it is to deal with these so-called genera in a systematic work, and also the great advantage of Tutt's method of making them tribal divisions that divide naturally into numerous very distinct genera (which, in turn, can be divided into subgenera and groups) without the whole matter becoming hopelessly involved.

For the sake of completeness, Watson's diagnosis of the subfamily is included; it is as follows:—

"Antennae seldom hooked, occasionally bluntly pointed. Palpi, with the 3rd joint either minute or porrected in front of the face, in the latter case, stout (and not slender as in the Entheid group of the PHOCIDINAE); palpi never curving over vertex. Fore-wing, cell less than two-thirds the length of costa; nervure 5, invariably nearer to 6 than to 4. Hind-wing frequently lobate, but never with a distinct tail or tooth at the submedian; nervure 5, never fully developed." (*Proc. Zool. Soc. London*, 1893, p. 16.)

As already noted, Tutt divided the HESPERIINAE into three tribes; the first, Nisoniadidi, he characterised by Watson's diagnosis of the genus *Thanaos*; the second, Erynnidi, by Watson's diagnosis of the genus *Carcharodus*; and the third, Hesperiidi, by Watson's diagnosis of the genus *Hesperia*. The diagnoses are as follows, all from the same paper. (Watson, *l.c.*)

"I. Tribe: NISONIADIDI.

"Antennae with club moderate, more or less bent into a curve, bluntly pointed. Palpi porrect; second joint laxly clothed; third joint almost concealed, bluntly conical. Fore-wing with inner margin longer than outer margin; male with a costal fold; cell of fore-wing less than two-thirds the length of costa; discocellulars slightly inwardly oblique, the lower the longer; nervure 3 shortly before the end of cell; nervure 2 slightly nearer to base of wing than to end of cell; discocellulars

and nervure 5 faint; nervure 3 immediately before end of cell; nervure 2 almost equidistant from end of cell and base of wing. Hind tibiae fringed, and with two pairs of spines, the upper pair minute.

"II. Tribe: ERYNNIDI.

"Antennae: club rather robust, straight, with an extremely minute blunt crook. Palpi suberect; third joint rather prominent; second joint rather laxly scaled. Fore-wing: inner and outer margins subequal; cell of fore-wing less than two-thirds the length of costa; male with a costal fold; vein 12 reaching costa well before the end of cell; discocellulars suberect, the lower the longer; vein 3 shortly before end of cell 4, twice as far from 2 as from 4; vein 2 twice as far from end of cell as from base of wing. Hind-wing: outer margin crenulate; vein 7 more than twice as far from 8 as from 6; discocellulars and vein 5 faint; vein 3 well before end of cell; vein 2 distinctly nearer to base of wing than to end of cell. Hind tibiae fringed, and with two pairs of spines, the upper pair minute.

"III. Tribe: HESPERIIDI.

"Antennae with club robust, arcuate, blunt at tip, no terminal crook. Palpi suberect; second joint laxly clothed with longish scales, third joint slender, blunt, almost concealed in scaling of second joint. Fore-wing with inner and outer margins subequal; cell less than two-thirds the length of costa; nervure 12 reaching costa well before end of cell; discocellulars suberect, the lower the longer; nervure 3, shortly before end of cell, more than twice as far from 2 as from 4; nervure 2 nearer base of wing than to end of cell. Hind-wing usually evenly rounded, occasionally slightly crenulate; nervure 7 very shortly before end of cell; discocellulars and nervure 5 very faint; nervure 3 immediately before end of cell; nervure 2 nearly equidistant from base of wing and end of cell. Hind tibiae with two pairs of spurs." (Watson, *l.c.*)

These three tribes are of the greatest value to a clear and simple classification. In the last one (Hesperiidi) fall all the species which we have to deal with in the systematic part of this work. Tutt classified these species in six genera, which appeared superficially to be very natural groups. When, however, one comes to look into the definitions on which these genera were based, the position is not so satisfactory. Tutt takes the grouping done by Speyer and Watson, which was based on the secondary sexual characters of the males, and makes it serve as a foundation for his genera; but he adds species freely to any genus, apparently without any regard to the definition given. Speyer's separations are quoted by Tutt as follows, the generic name and type species given in brackets after each section having been added by Tutt.

"A.—Male with costal fold.

"(*a*) Stoutly built species, with deeply waved-toothed hind-wings, and with transparent spots on the fore-wings—*lavatherae*, Esp., *althaeae*, Hb., *alceae*, Esp. (*Erynnis*, Schrk. Type *alceae*.)

"(*b*) Hind-wings more deeply dentated, or with the margins entire; fore-wings without transparent spots—*proto*, Esp., *tessellum*, Hb., *cribrellum*, Ev. (*Muschampia*, n.g. Type *proto*, Esp.)

"B.—Male without costal fold. Hind-wings slightly dentated.

"(*a*) Club of antenna longer than in the other species, bent behind the middle, and thence to tip much reduced. Male with a trace of the costal fold—*poggei*, Led. (*Sloperia*, n.g. Type *poggei*, Led.)

"(*b*) Club of antenna straight or only slightly bent, rounded at tip—*phlomidis*, H.-Sch., *sao*, Hb., *orbifer*, Hb. (*Powellia*, n.g. Type *sao*, Hb.) (Speyer.)"

Watson's separations are quoted by Tutt as follows, and as before the generic names and type species were added by Tutt.

"1. Male without costal fold and without tuft of hairs on hind tibiae—*spio*, L., *sataspes*, Trim., *zebra*, Butl., *galba*, Fab., *evanides*, Butl., *diomus*, Hopff., *asterodia*, Trim., *dromus*, Plötz, *vindex*, Cram., *transvaaliae*, Trim., *orbifer*, Hb., *sao*, Hb., *phlomidis*, H.-Sch., *geron*, Wats. (*Powellia*, n.g. Type *sao*, Hb.)

"2. Male with a costal fold; no tuft of hairs on the hind tibiae, but with these tibiae furnished with numerous short spines—*cribrellum*, Evers. (*Favria*, n.g. Type *cribrellum*, Evers.)

"3. Male with a costal fold, but with no tuft of hairs on hind tibiae—*tessellum*, Hb., *gigas*, Brem., *nomas*, Led., *poggei*, Led., *proto*, Esp., *americanus*, Blanch., *syrichtus*, Fab., *montivagus*, Reak. (*Muschampia*, n.g. Type *proto*, Esp.)

"4. Male with a costal fold and with a tuft of hairs on hind tibiae—*cashmirensis*, Moore, *cacaliae*, Ramb., *serratulae*, Ramb., *alveus*, Hb., *andromedae*, Wallgrn., *centaureae*, Ramb., *hypoleucos*, Led., *malvae*, Linn., *cynarae*, Ramb., *carthami*, Hb., *sidae*, Esp., *antonia*, Spey., *sinicus*, Butl., *maculatus*, Brem., *bocchoris*, Hew., *fulvovittatus*, Butl., *trisignatus*, Mab., *asychis*, Godt. (*Hesperia*, Fab. Type *malvae*, L.)" (Tutt, *Brit. Lepidopt.*, vol. viii, p. 218.)

On examining these divisions and the resulting genera, certain points are obviously not satisfactory.

The position of *poggei* at once attracts attention: classed by Speyer as without, and by Watson as with a costal fold. Of course it is not easy to say which has the greater claim to accuracy. In one sense the slight ridge on the costa in *poggei* cannot be said actually to be a fold; but, on the other hand, its analogy to that structure in other species is so obvious, that it must be considered a rudimentary one. The same vexed point naturally affects the near allies of *poggei* too. Speyer, however, added in his diagnosis, "male with a trace of the costal fold," which is accurate but makes one wonder why he included it under section B, "male without fold."

Then, according to Speyer, *cribrellum* and *tessellum* are congeneric, while according to Watson they are not.

The very slight difference between Watson's 2nd and 3rd divisions hardly strikes one as being a worthy character on which to divide a genus; while in his 4th division ("male with a costal fold," etc.) the first species mentioned is *cashmirensis*, which has no fold, and *antonia* is also included, although it too is without a fold.

Tutt evidently found these definitions impracticable, for the final classification he employed shows he quite disregarded them in practice, though still retaining them in theory. Thus, he gives us the genus *Sloperia*, containing *poggei* and *lutulentus*; genus *Muschampia*: *proto*, etc.; genus *Favria*: *tessellum*, *nomas*, *gigas*, *cribrellum* and *nobilis*. The latter genus was founded on Watson's 2nd division for *cribrellum*, but Tutt places in it *tessellum*, *nomas* and *gigas*, from Watson's 3rd division (*Muschampia*); and of the two latter species (*nomas* being conspecific with *tessellum*) *tessellum* falls under *Muschampia*, in Speyer's division two. The genus *Powellia* stands by its definition, but *Hesperia* has been further divided and a few species, *maculata*, *bieti*, etc., placed in another genus, *Bremeria*, for which no definition whatsoever is given. *Maculata* was previously located in Watson's 4th division. To the two species mentioned as having no costal fold, but which were all the same included in division four, is added *alpina*, yet another species without a costal fold.

Of these six genera only two remain that correspond with the definitions on which they are supposed to be founded; but, all the same, anyone familiar with the insects concerned would probably say that Tutt's final arrangement

appeared to be a much more natural grouping of the species than either Speyer's or Watson's.

This arrangement cannot be retained as a scientific classification, but it serves to demonstrate the futility of trying to classify the species of the tribe Hesperiidi by the secondary sexual characters of the male; and further, if the work of other authors on the same lines be consulted, it only gives one a greater number of conflicting statements.

It is therefore necessary to employ some other characters, and as the genitalia had already given such valuable results in the past, in dealing with the difficulty of separating species from species, it was hoped that these organs would prove equally helpful in the question of genera, especially as the neuration is so generalised as to be entirely useless for systematic purposes.

A careful study of the genitalia gave extremely interesting and useful results. Some of Tutt's genera were shown to be very natural and distinct genera; others were rather mixed quantities.

It may be asked at this point, why we do not follow the old custom, and lump all the species of black and white "Skippers" in one genus? Our reasons for not doing so have been, in part, mentioned before. Briefly stated, they are: (1) that the genera into which the species of the tribe Hesperiidi naturally divide are anatomically very widely separated from each other, and that several of these genera further subdivide into numerous distinct groups and subgroups; and (2) that no concise systematic treatment of the genera can be carried out without carefully distinguishing these further subdivisions; and this being the case it is far simpler to separate the main divisions as genera, and the lesser ones as subgenera and groups.

This naturally raises the very interesting question of the difference between a group and a genus. Looked at in one sense, these terms are, of course, synonymous; but, in another, it seems to me that a genus can claim certain elements which are wanting in a group. In other words, one may frequently find groups of species in a genus which, although of pronounced character, are still lacking in a certain element necessary to a genus. For instance, if one finds a number of groups in which the individuals of any one are, morphologically, obviously nearly related, and equally obviously widely disconnected from the members of the others groups, I would claim that such a group had lost the common link which connected it with the other groups, as members of a common body, and had become an independent group, *i.e.* a genus; and that it should be treated as such, even if there were no pronounced superficial features by which it could be distinguished from the other groups with which it had been associated. This, however, will probably be found to be a rare occurrence. Further, in all the well-defined groups of individuals in one genus, which are still true divisions of one genus, the members of any one group must still, morphologically, be quite distinctly connected with the members of all the other groups; they must, in fact, still show the generic characters common to every group; and such a collection of individuals, I would say formed a true group, as opposed to a genus. This being so, one can point out that the groups employed by the various authors who retain all the species of the tribe Hesperiidi as one genus will not stand this test; and it therefore appears to me that from a scientific point of view there is nothing to be said in favour of such classification, and that Tutt was undoubtedly right in converting such a genus into a tribe and endeavouring to establish other genera. It was therefore a pleasure to find that the classification derived from the characters given by the genitalia enabled one to retain four of his six genera.

Before proceeding with the definitions of the various genera, it is necessary to note that it is usually the dorsal armature which is supposed to give the best generic characters, when considering lepidopterous insects; but, in the case of the Hesperids, this is not the case. If one were to employ the characters of the dorsal parts only, it would become necessary to break up the restricted genus *Hesperia* (as used in this work) into eight genera, which would separate many species which are very closely allied. The characters of the 10th sternite and harpe have therefore been selected (both the development and position of the latter being taken into consideration), and this combination of structures is felt to be of far more classificatory value than if the characters of one structure alone were used. The selected structures are parts of two separate segments, the 10th sternite, and the dorsal aspect of the lateral apophyses of the 9th sternite, whereas a classification based on the formation of the uncus depends entirely on the dorsal aspect of one segment. Moreover, the characters provided by the two selected parts not only give one a natural and clearly defined grouping of the species composing the tribe Hesperiidi, but are equally valuable when applied to the species of the whole subfamily HESPERIINAE.

Although I have no very great knowledge of the non-palaearctic species, the few with which I am acquainted suggest that these characters would apply with equal value to the HESPERIINAE of any region. Further, if one looks into any of the schemes for classification that have been based on the genitalia, it will be apparent that, if characters from both segments had been considered, in the majority of cases it would have given a more comprehensive and natural classification, and avoided undue multiplication of genera. Of course, it may be said that the dorsal elements of the genitalia are parts of both 9th and 10th segments; but though this is so, it is almost always the 10th segment alone which is dealt with, *i.e.* the uncus, and perhaps sternal portions of the same segment. The actual tegmen is hardly ever referred to.

In the following list of genera only the type species of each is mentioned.

Tribe: NISONIADIDI.

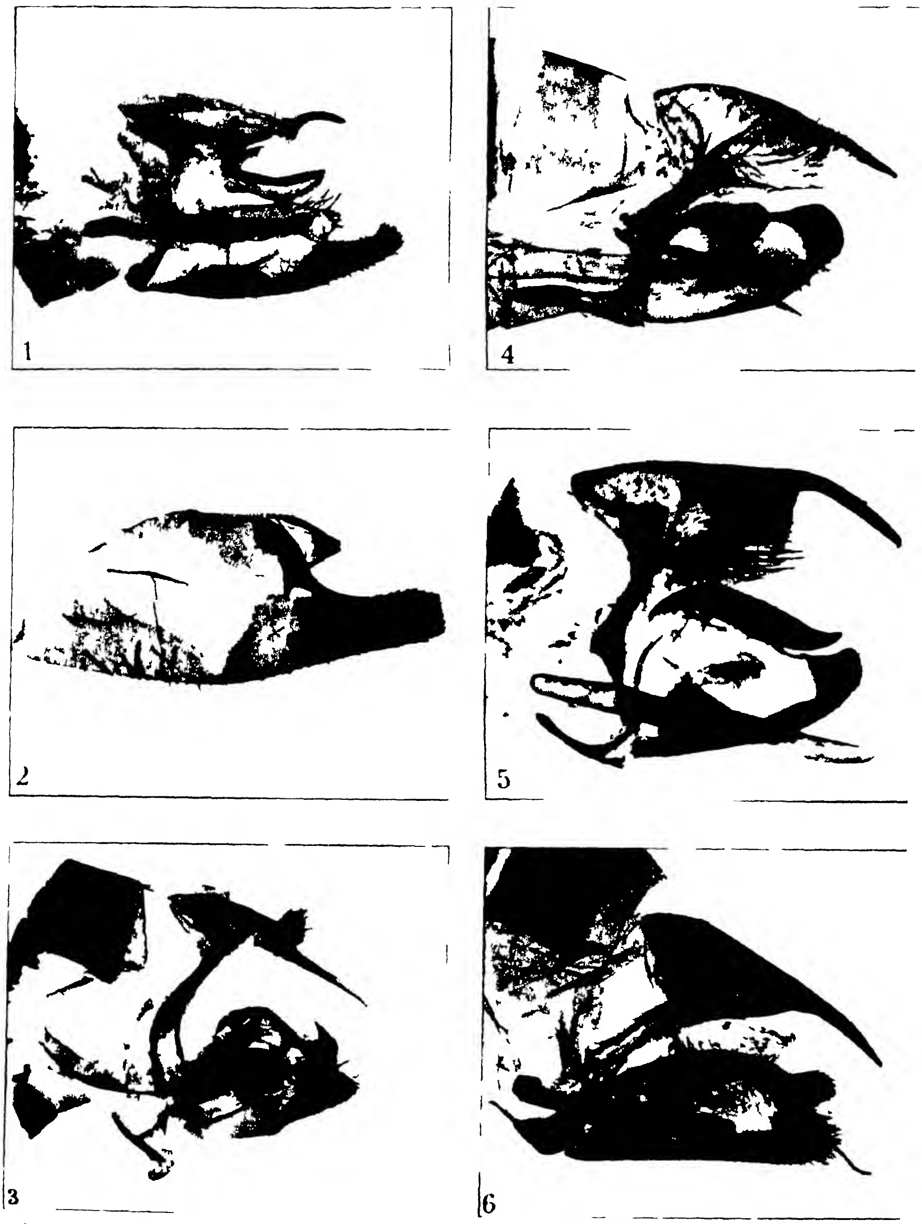
I. Harpe, not fully developed; proximal half wanting, entirely, or almost so; short; not extending to distal extremity of clasp; terminating on proximal edge of cuiller; without style or antistyle: 10th sternite partially developed, united ventrally = **Nisoniades,** Hb. Type *tages*, Linn. (Includes *marloyi*, type of *Hallia*, Tutt, which falls.)

Tribe: ERYNNIDI.

I. Harpe, not fully developed; central portion wanting, proximal and distal portions barely united by narrow strip along dorsal ridge; long; extending to distal extremity of clasp; terminating on proximal edge of cuiller; style wanting; antistyle present: 10th sternite wanting; slight detached rudiments of ventral plate visible in membrane completing 10th segment = **Erynnis,** Schrk. Type *alceae*, Esp.

II. Harpe, strongly developed; short; of unequal widths; not extending to distal extremity of clasp; terminating before proximal edge of cuiller; without style or antistyle: 10th sternite represented by a restricted, and slightly chitinised, membranous process; with certain lateral portions purely membranous (unchitinised) = **Spilothyrus,** Dup. Type *althaeae*, Hb.

III. Harpe, strongly developed; long; of equal width throughout; almost extending to distal extremity of clasp; terminating above cuiller; distal extremity free, not in contact with any part of clasp; without style or antistyle: 10th sternite represented by an extended, membranous process; slightly, but broadly chitinised; no purely membranous parts remaining = **Carcharodus,** Hb. Type *lavatherae*, Esp.



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Types of genera Male armatures

1 *Nisoniades tages*

2 ,, Left clasp

3 *Erynnis alceæ*

4 *Spilothyrus althææ*

5 *Carcharodus lavatheræ*

6 *Rамburia antonia*

Tribe : Hesperiidi.

I. Harpe, strongly developed; short; not extending to distal extremity of clasp; terminating on or before proximal edge of cuiller; bearing style and antistyle : 10th sternite fully or partially developed, complete or incomplete ventrally = **Hesperia,** Fab. Type *malvae,* Linn. (Includes all the species of *Bremeria,* Tutt, which falls.)

II. Harpe, strongly developed; long; extending to distal extremity of clasp; terminating on summit of cuiller; bearing style; without antistyle : 10th sternite wanting = **Ramburia,** gen. nov. Type *antonia,* Spr.

III. Harpe, strongly developed; long; extending to distal extremity of clasp; terminating on summit of cuiller; without style or antistyle : 10th sternite partially developed; united, or not united ventrally = **Powellia,** Tutt. Type *sertorius* Hoffmsgg. (= *sao,* Hb.).*

IV. Harpe, strongly developed; long; extending to distal extremity of clasp; terminating on proximal edge of cuiller; without style or antistyle : 10th sternite partially developed, not united ventrally = **Sloperia,** Tutt. Type *poggei,* Led. (Includes *proto,* type of *Muschampia,* Tutt, which falls.)

V. Harpe, strongly developed; long; extending to distal extremity of clasp; terminating on proximal edge of cuiller; without style or antistyle : 10th sternite wanting = **Reverdinia,** gen. nov. Type *staudingeri,* Spr.

VI. Harpe, very slightly developed; short; not extending to distal extremity of clasp; terminating before proximal edge of cuiller; without style or antistyle : 10th sternite wanting = **Tuttia,** gen. nov. Type *tessellum,* Hb.

This genus is further distinguished from all others, by the presence of a pair of very strong chitinous processes on each side of the ædoeagus; roughly wing-shaped, originating from the penis-sheath.

VII. Harpe, strongly developed; short; not extending to distal extremity of clasp; terminating on proximal edge of cuiller; style wanting, strongly developed antistyle present : 10th sternite partially developed united ventrally = **Favria,** Tutt. Type *cribrellum,* Evers.

The complete list of species in each of the above genera will be found in the Synonymic List of the Palaearctic Hesperiinae at the end of this memoir. The genitalia of the type species of each genus in the tribes Nisoniadidi and Erynnidi are figured on Pl. III; and of the non-European species of the tribe Hesperiidi on Pls. IV–IX, the European species of the latter being figured as dealt with in our systematic account of the tribe.

The older generic names employed in the above classification require a word of explanation. Tutt, in his *British Lepidoptera,* worked out the question of the names applicable to the various Urbicolid genera in detail. As this question is of considerable importance in this revision of the tribe, we give his complete list of generic names and types, to make our reasons for using the names, as we have, perfectly clear.

Tutt's résumé is as follows (*Brit. Lepidopt.* viii. pp. 84 and 85) :—

"1758. Urbicola, Linn.—Type fixed in 1781 by Barbut as *comma,* Linn.

"1793. Hesperia, Fab.—Type fixed in 1798 by Cuvier as *malvae,* Linn.

"1801. Erynnis, Schrk.—Type fixed in 1820 by Oken as *alceae,* Esp. (*malvae,* Schrank).

"1806. Urbanus, Hb.—*Malvae,* Hb. (= *alceae,* Esp.), the only species mentioned, and therefore the type. Consequently falls before *Erynnis,* Schrank.

"1806. Heteropterus, Dum.—Type fixed in 1823 by Dumeril as *morpheus,* Pallas, which he figures.

"1807. Thymele, Fab.—Contains *malvae,* Linn. (under the name *lavaterae*), the type of *Hesperia,* Fab., before which it therefore falls.

* For details as to the change of name of this well-known species, see Part X.

"1807. PAMPHILA, Fab.—Type fixed in 1840 by Westwood as *comma*, Linn., the name, therefore, falls before *Urbicola*, Linn.

"1815. THYMALE, Oken.—Used for several groups of species. Evidently a *laps. cal.* for *Thymele*, Fab., a synonym of *Hesperia*, Fab.

"1816. NISONIADES, Hb.—Type fixed in 1834, and confirmed in 1850, by Stephens as *tages*, Linn.

"1816. PYRGUS, Hb.—Type fixed in 1834, and confirmed in 1850, by Stephens as *alveolus*, Ochs. = *malvae*, Linn. Falls therefore, as a synonym of *Hesperia*, Fab.

"1816. CARCHARODUS, Hb.—Typical coitus of *Urbanus*, Hb., containing *malvae*, Hb. (= *alceae*, Esp.), which therefore becomes the type, the genus falling before *Urbanus*, Hb., and *Erynnis*, Schrk.

"1816. CYCLOPIDES, Hb.—Restricted in 1834 by Stephens, to *paniscus*, Fab., and *sylvius*, Knoch. Type fixed in 1850 by Stephens, and confirmed by Westwood and Hewitson in 1852, as *paniscus*, Fab. (= *palaemon*, Pallas).

"1816. AUGIADES, Hb.—Restricted in 1834 and 1850, by Stephens to *comma*, Linn., and *sylvanus*, Esp. Type fixed by Scudder in 1872 as *sylvanus*, Esp. (Butler's action, in 1870, of overriding Stephens' restriction of 1850, is *ultra vires*.)

"1816. THYMELICUS, Hb.—Restricted in 1850 by Stephens to *thaumas*, Hufn., and *acteon*, Rott. (also in 1834 under the *laps. cal. Thymelinus*). Under the same misspelling in 1858 Kirby fixed the type as *acteon*, Rott.

"1820. ADOPAEA, Billbg.—Created for *thaumas*, Hufn., and a MS. species, the former therefore becoming the type. Type confirmed in 1893 by Watson.

"1832. STEROPES, Bdv.—Name preoccupied in Coleoptera (Stev., 1806).

"1832. THANAOS, Bdv.—*Tages*, Linn., was figured in 1836 by Boisduval under this name. Type specified as *tages*, Linn., by Blanchard, in 1846; the name therefore, falls as a synonym of *Nisoniades*, Hb.

"1832. SYRICHTUS, Bdv.—Restricted in 1840 by Blanchard to *malvae*, Hb. (*alceae*, Esp.) and *alveolus*, Ochs. (= *malvae*, Linn). "Anon," in 1841, in the *Isis*, cites only *malvae*, Linn., which therefore becomes the type. Falls as a synonym of *Hesperia*.

"1834. THYMELINUS, Stphs.—A misprint for *Thymelicus*, Hb. The misspelling repeated by Kirby in 1858, when *acteon* was cited as the type. Falls before *Thymelicus*, Hb.

"1844. SPILOTHYRUS, Dup.—Created for *alceae*, Esp., *althaeae*, Hb., and *lavatherae*, Esp. Contains *alceae*, Esp., the type of *Erynnis*, before which it falls, all three species being congeneric.

"1852. CARTEROCEPHALUS, Led.—Proposed to replace *Steropes*, Bdv., preoccupied. Type fixed in 1867 by Snellen as *palaemon*, Pallas; it falls therefore, as a synonym of *Cyclopides*, Hb."[1]

Of the above names, I retain all those Tutt shows to be valid for use in the subfamily HESPERIINAE, and two which he did not consider valid: *Carcharodus* and *Spilothyrus*.

Of the former he writes:—"Typical coitus of *Urbanus*, Hb., containing *malvae*, Hb. (= *alceae*, Esp.), which therefore becomes the type, the genus falling before *Urbanus*, Hb., and *Erynnis*, Schrk."

The genus *Carcharodus* was erected by Hübner for *lavatherae*, *althaeae* and *malvae*, Hb. (= *alceae*, Esp.), without any particular insect being cited as type. The fact that *malvae*, Hb. (*alceae*) was already the type of *Urbanus* does not prevent *Carcharodus* being retained as a genus containing one of the other species originally placed in it, as they are not congeneric. I therefore retain it for *lavatherae*, Esp., and *tauricus*, Rev., taking the former as type.

Concerning *Spilothyrus*, Tutt says:—"Created for *alceae*, Esp., *althaeae*, Hb., and *lavatherae*, Esp. Contains *alceae*, Esp., the type of *Erynnis*, before which it falls, all three species being congeneric."

The same remark applies to this case as the last. The three species are not congeneric, but units of three most distinct genera. *Alceae* is type of *Erynnis*, *lavatherae* I have cited as type of *Carcharodus*, therefore *Spilothyrus* is available for *althaeae* and its allies; and I take *althaeae*, Hb. as type.

There will, no doubt, be many entomologists who will disapprove of the division which places the species of the tribe Erynnidi in three genera; the old

habit of keeping the three coloured European species in one genus will seem to them much better, especially as two of these species are, superficially, somewhat similar. I can sympathise with this idea, but the division is essential: the remarkable thing is that it has not been made before. The three common European species, *alceae*, *althaeae* and *lavatherae*, are very widely separated, being even less connected than the definitions of the three genera might lead one to suppose. Some idea of this can be gathered if we study the genitalia comparatively with some other species. *E. alceae* shows more affinity to the species of the genus *Sloperia* than to *S. althaeae*! *C. lavatherae* and the congeneric *tauricus*, although possessing, more or less, the same extraordinary process representing the 10th sternite as *althaeae*, etc., show how widely they are separated from those species by the form of the harpe; a type unknown in any other Palaearctic species, but which shows a decided relationship to the harpe we find in the Ethiopian species *spio*! (= *vindex*). This shows how little in common there really is between *alceae*, *althaeae* and *lavatherae*, and will perhaps help to reconcile those who are opposed to this absolutely essential change.

The superficial characteristics of the genera we have defined must be briefly recorded, as all the genera will not be dealt with in our systematic part.

Genus *Nisoniades*, Hb.: Dark brown species, fore-wings upperside with inconspicuous variegated pattern, but no transparent spots.

Genus *Erynnis*, Schrk.: Dark brown species shaded with mauve, fore-wings upperside with inconspicuous variegated pattern and very small transparent spots. Fore-wings underside (in male) without brush of hairs.

Genus *Spilothyrus*, Dup.: Dark brown species, with green or mauve tinge, fore-wings upperside with inconspicuous variegated pattern and large transparent spots. Fore-wings underside (in male) with thick brush of hairs.

Genus *Carcharodus*, Hb.: Yellowish-green or yellowish-brown species, fore-wings upperside with conspicuous variegated pattern and very large transparent spots. Fore-wings underside (in male) without brush of hairs.

Genus *Hesperia*, Fab.: Black species with white spots on upperside, fore-wings with median row of spots complete, but sharply angled, 6th spot moved outwards nearer to outer margin of wing than any other spot of the row.

The position of the 6th spot of the median row is invariable in every one of the thirty-two species of the genus. It is noteworthy that in *antonia*, which was always included in the genus *Hesperia*, but which the genitalia show to belong to a widely separated genus, this character is wanting; also that in the species included in Tutt's *Bremeria*, which cannot be separated, anatomically, from *Hesperia*, all show this specialised feature.

Genus *Ramburia*, Warr.: Black with white markings on upperside, fore-wings with outer row of spots strongly developed, median row complete, its 1st, 2nd, and 3rd spots united with those of discoidal series, forming a very broad central band.

Genus *Powellia*, Tutt: Black species with white or ochreous spots on upperside; outer row of spots on fore-wings complete, but very small and sharply defined, situated nearer to outer margin of wing than to the median row of spots. Median row complete or incomplete, discal spot half-way between discoidal lunule and median row, 5th black bar of fringe of fore-wing usually wanting.

Genus *Sloperia*, Tutt: Brownish-black species with white spots on upperside;

outer row of spots fore-wing present, strongly developed or very faint; median row incomplete, 5th and 6th spots wanting; discal spot nearer to discoidal lunule than median row. Outer edge of central spot of median band underside, straight or concave, not united with the apex of spot 5 of marginal row.

Genus *Reverdinia*, Warr.: Brownish-black species with white spots on upperside; outer row of spots fore-wing wanting; median row incomplete; discal spot closer to discoidal lunule than to median row. Outer edge of central spot of median band underside, convex, or projecting sharply outwards towards the margin, uniting with apex of spot 5 of marginal row.

Genus *Tuttia*, Warr.: Brownish-black species, with white spots on upperside, which is thinly, but broadly dusted with greenish superscaling; outer row of spots fore-wing complete, strongly but not sharply developed, equidistant from median row and margin of wing; median row incomplete; discal spot almost half-way between discoidal lunule and median row.

Genus *Favria*, Tutt: Brownish-black species, with white spots on upperside, which is thinly dusted with greyish-green superscaling, but only on the basal area of the wings; outer row of spots fore-wing complete and very strongly developed, equidistant from the median row and margin of the wing; median row complete; discal spot (on upperside) wanting, or very faintly marked.

IV. The Natural Subdivisions of the Genera *Hesperia* and *Powellia*

In the genus *Hesperia* (*sens. strict.*) we find those species that have been for so long a difficulty to the student and collector alike, and which form, without doubt, the most difficult group of European (if not Palaearctic) butterflies to identify by superficial means. Still, although a certain amount of difficulty must probably always remain in connection with these species, it is not at all an impossible task for the trained eye to identify a very large proportion of them with certainty by their superficial facies alone.

A study of the groups into which the species of *Hesperia* naturally divide has been of great assistance in facilitating identification, and anyone interested in the Hesperids should become thoroughly conversant with them. These groups are very clearly indicated by the male armature.

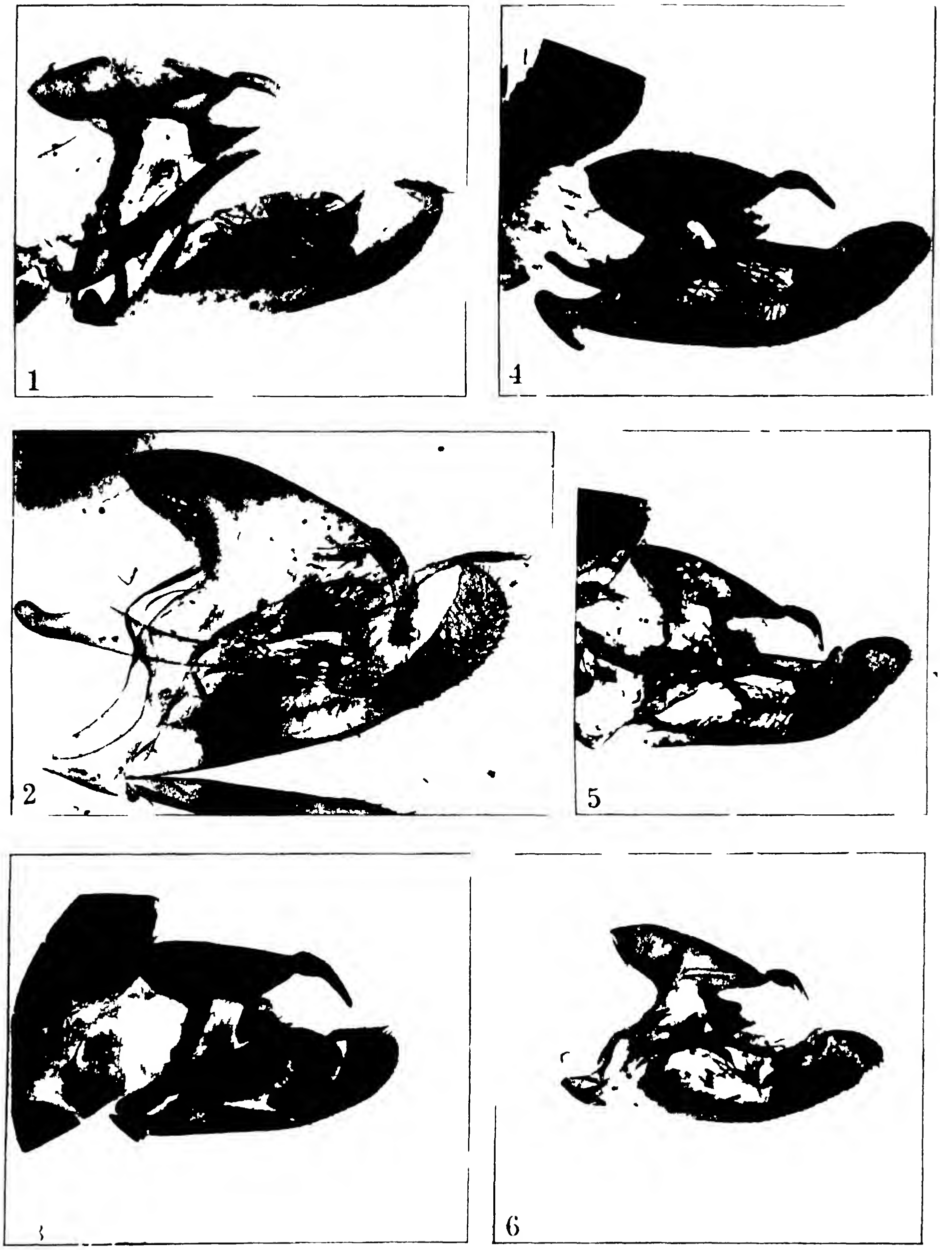
Three main divisions of the genus must first be noted; they consist of:—

I. Those species in which the 10th abdominal segment in the ♂ forms a complete circle, the ventral plate of the sternite being a simple, broad chitinous structure, united solidly with the dorsal portion of the segment.

II. Those species in which the 10th abdominal segment in the ♂, though still forming a complete circle, has the sternite so modified and reduced as to be scarcely discernible, whilst from it originate highly developed lateral apophyses, which are united at their basal extremities by a narrow chitinous band that completes the ring of the segment.

III. Those species in which the 10th abdominal segment in the ♂ no longer forms a united circle; the sternite being reduced as in the last division, and bearing lateral apophyses, but these are not connected ventrally.

These three groups, or rather subgenera, for two of them are composed of a number of smaller groups, will be referred to as the subgenera **Teleomorpha** (nov.),



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Male armatures of *Hesperia*. Non European species.

1. *H. sibirica*
2. *H. chapmani*
3. *H. alpina*
4. *H. maculata*
5. *H. zona*
6. *H. albistriga*

Hemiteleomorpha (nov.), and **Ateleomorpha** (nov.), respectively. (Greek: Teleos = complete, and morphe = form.)

It is necessary to have distinctive names for these subgenera, for if such divisions are to be of any real practical use they must have names; this gives them a greater prominence than describing them as section "A" or "B," and enables them to be referred to in conversation, which the latter form of designation practically prohibits.

The species of the subgenus *Teleomorpha* belong to three very distinct groups, and those of the subgenus *Ateleomorpha* to four; the species of *Hemiteleomorpha* are all fairly closely allied, and do not need further division.

These various groups are definable as follows:—

Subgenus *Teleomorpha*.

I. Tenth sternite in male simple and entire; whole length of dorsal edge of harpe curved; style long and folded over close to harpe = *Centaureae* Group, and includes *centaureae, freija, andromedae, cacaliae, sidae*, etc.

II. Tenth sternite in male simple and entire; posterior half of dorsal edge of harpe flat; style very short, broad and not folded = *Maculata* Group, and includes *maculata*, etc. (No European species.)

III. Tenth sternite in male simple and entire; whole length of dorsal edge of harpe curved; style short and narrow, not folded = *Carthami* Group, and includes *carthami*, etc.

Subgenus *Ateleomorpha*.

I. Tenth sternite in ♂ incomplete; lateral apophyses highly specialised, spined processes long and narrow; cuiller small, short, and very broad, proximal edge curved; style short, moderately broad and straight; ventral outline of clasp convex = *Onopordi* Group, *onopordi* standing alone.

II. Tenth sternite in ♂ incomplete; lateral apophyses highly specialised, short, and bearing numerous short spines; cuiller large and broad, proximal edge practically straight, uniting with the stylifer at half its length; style slender, long, and more or less curved; ventral line of clasp flat = *Serratulae* Group, and includes *serratulae, carlinae* and *fritillum*.

III. Tenth sternite in ♂ incomplete; lateral apophyses short and more or less triangular in form; cuiller highly developed on lines of *serratulae* group, but very large, equal to, or more than, half the total dimension of the clasp; the proximal edge uneven, uniting with the stylifer at about one-third of its length; style short, slender and curved; ventral line of clasp concave = *Alveus* Group, and includes *alveus, armoricanus, foulquieri*, etc.

IV. Tenth sternite in ♂ incomplete; lateral apophyses and cuiller as in the *alveus* group, but the latter slightly narrower; style very long and slender, folded over at its base; ventral line of clasp straight = *Cinarae* Group, *cinarae* standing alone, no other species at present known combining such remarkable characters of style and cuiller.

The affinities of these several groups of the subgenus *Ateleomorpha* are of considerable interest. The remarkable formation of the cuiller in the *serratulae* group, and its obvious approximation to that structure in the *alveus* group, very naturally tempts one to suggest that the forms contained in the latter have been derived from the former, and merely show us a further stage in the development of a particular structure. Further, if one looks at the form of the cuiller in some species of the *centaureae* group, as for example *alpina, sibirica*, etc., one cannot but be struck by the natural transition which it makes in

the *serratulae* group between the former species and those of the *alveus* group. But, if we turn to the *cinarae* group, we at once meet with a fact which refutes this theory; and, though it does not help to explain the cause of the fundamental similarity of structure in the two former groups, it shows more or less conclusively that the evolution of the *alveus* group took place quite independently of the *serratulae* group. In *cinarae* the cuiller is developed as in the *alveus* group, but, in addition, the harpe supports a style of the same remarkable formation as found in certain species of the *centaureae* group and unknown elsewhere. The affinity of this style to those of *centaureae, sidae, sibirica,* etc., is as pronounced as the affinity of the cuiller to those of *alveus* and its allies; and when one considers this most remarkable combination of characters in one species, it is impossible to do otherwise than accept that species as a link between the two groups in question. It might be suggested that the earlier representatives of the *alveus* group, and *cinarae*, had been independently evolved; but the absolutely complete analogy of the cuiller and lateral apophyses in *alveus* and its allies, and *cinarae*, excludes such a possibility, and we must accept the fact that the species of the *alveus* group, and *cinarae*, are directly evolved from the same form, in which the cuiller and lateral apophyses were already developed as we now see them. From this it follows, as we can with a fair amount of certainty maintain the species of the *centaureae* group as among the least modern species of *Hesperia* now in existence, that the type of style common to *cinarae* and *centaureae*, etc., is the older type, and that it was lost by *alveus* and its allies and retained by *cinarae*. That the stylar formation could have been so completely altered, while the other parts of the clasp remained more or less similar, may at first seem highly improbable; but in reality it does not necessitate any tremendous change, or even come as an entirely new development on the part of the *alveus* group species, for many types of style exist among the present members of the subgenus *Teleomorpha*. From this, it is evident that a strong tendency must have been latent in these species for specialisation in stylar formation, and therefore a comparatively slight incentive might have been sufficient to bring about the change which separated the *alveus* and *cinarae* groups.

I have said that we can maintain with a fair amount of certainty that the species of the *centaureae* group are among the least modern species of *Hesperia* now existing. There are several very potent reasons for this assumption, which it may not be out of place to mention here. First of all, the affinities of all the species of the subgenus *Teleomorpha* are extremely close, so we may take any evidence we find relating to one species as applicable to all. The complete and simple, and undoubtedly primitive, formation of the 10th segment in the male is peculiar to the subgenus, and, considered with the geographical distribution of the species as a whole, strongly points to their being less removed from the original common ancestor of the genus than any other species. The 10th segment of the male is united ventrally in species of some of the other genera, but in these the ventral plate is extremely narrow as a rule, and often very thin and feebly constructed. The side pieces are highly specialised, after the manner of the lateral apophyses prevailing in many species of *Hesperia*, and the whole sternite is very different from that existing in the subgenus *Teleomorpha*, serving to emphasise the simple character of the latter. Then further, in some species of the *maculata* group we find the primary semiclasp more nearly entire than is the case in any of the other species. In two species in particular, there is only a very small area between the antistyle and the cuiller which is unchitinised. The subharpal plate is united to both harpe and

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Male armatures of *Hesperia* Non European species

1 *H thibetana*
2 *H cashmirensis*
3 *H beiti*
4 *H oberthuri*
5 *H pontica* (Without clasps
6 *H pontica* (Right clasp)

J. Dale, S. & D. Ltd. Photo. J. Tullis

Male armatures of *Powellia* and *Hesperia*. Non-European species.

1. *H. speyeri*
2. *H. reverdini*
3. *H. schansiensis*
4. *P. ali*
5. *P. geron*
6. *P. galba*

ventral plate, and in *maculata* to the cuiller also. The density of the chitinised membrane all over the central area varies to a considerable extent. The area surrounding the subharpal plate, which in most species is entirely membranous, is less strongly chitinised than the other parts, but still is not membranous; and there is no break in the continuity of the chitinous surface, from the ventral plate to the harpe. Under the microscope, a strong power shows the varying density of the chitinisation distinctly, and how it passes insensibly from the thinnest areas to the most solid parts of the harpe, etc.

This varying quality of density shows us very plainly how the present formation of the primary semiclasp has been attained, or rather how the many different formations it now exhibits have been developed. The primary semiclasp in *maculata* and *zona* is undoubtedly a transition between the most usual types at present in existence and what must have been the primitive formation; and, as in all the species of the subgenus *Teleomorpha* the primary semiclasp is developed on the same lines (only slightly less chitinised), the same applies to them.

The above facts seem quite sufficient proof that the members of the subgenus *Teleomorpha* are, as I said of *centaureae* and its allies, the least modern branch of the subfamily Hesperiinae.

If we now turn again to the *serratulae* group, it is at once obvious that, in spite of its suggestive resemblance, the cuiller in these species cannot be accepted as illustrating a certain stage in the evolution of that structure as seen in the *alveus* group; for, if it really did so, it must be accompanied by the ribbon-like, folded style, which, as we have already seen, must have been a feature of the clasp in the *alveus* group until the cuiller had attained the form and dimensions typical of *cinarae*, i.e. considerably more developed than in any species of the *serratulae* group. The most that can be said then, in regard to the similarity of the cuiller in the *serratulae* and *alveus* groups, is that it is most probably the result of analogous variation in two groups of species more or less nearly connected, but which, as the lateral apophyses show, have developed on separate lines.

Before leaving this subject we must refer to *onopordi*. The form of the clasps gives a plain indication that *onopordi* came to Europe from the east, and that it is a modern branch of the same line as *thibetana*. It has become a highly specialised species, and no longer closely connected to any existing species. However, it forms a kind of link between the *maculata* group and the *malvae* group (*Hemiteleomorpha*), though showing greater affinities to the former. The short, thick, straight style is common to *malvoides*, *melotis* and *pontica*, which species also, together with *malvae*, show distinct relationship to *onopordi* in the form of the lateral apophyses and the restricted, broad stylifer. The uncus in *onopordi* is nearer to that of the *serratulae* group, as is also the formation of the ventral aspect of the lateral apophyses, which are not united as in the *malvae* group. All this shows how isolated the position of *onopordi* has become.

The Palaearctic species of *Hesperia* fall into the groups which we have described, as follows :—

Subgenus *Teleomorpha* :

I. *Centaureae* group—*centaureae*, *freija*, *sibirica*, *chapmani*, *andromedae*, *cacaliae*, *sidae*, *alpina*.

II. *Maculata* group—*maculata*, *zona*, *albistriga*, *thibetana*.

III. *Carthami* group—*carthami*, *cashmirensis*, *bieti*, *oberthüri*.

Subgenus *Hemiteleomorpha* :—*malvae*, *malvoides*, *pontica*, *melotis*.

Subgenus *Ateleomorpha.*

I. *Onopordi* group—*onopordi.*

II. *Serratulae* group—*serratulae, carlinae, fritillum.*

III. *Alveus* group—*alveus, numida, armoricanus, foulquieri, speyeri, reverdini, schansiensis.*

IV. *Cinarae* group—*cinarae.*

(For description of *chapmani*, see Part VIII.)

Turning to the genus *Powellia*, contrary to what might be thought, matters are somewhat complicated. Structurally the species fall into two very distinct groups, but superficially these groups cannot be as clearly separated from each other as is desirable. On the characters of the male armature they can be defined as :—

I. Those species in which the lateral apophyses of the 10th sternite are united ventrally, to a greater or less extent = *Geron* Group, and includes *geron, struvei* and *adenensis.*

II. Those species in which the lateral apophyses of the 10th sternite are not united ventrally = *Sertorius* Group, and includes *sertorius* (*sao*), *therapne, ali, orbifer, phlomidis* and *galba.*

It is probable that in the future these groups will have to be taken as subgenera, and further subdivided. The formation of the harpe is very different in *phlomidis* from that of the other five species of the *sertorius* group; while the 10th sternite in *geron* and *struvei* is decidedly different from *adenensis*, and there is also some harpal difference. In the two former, it is probably correct to say that it is the lateral apophyses which are united by a small ventral band, while in *adenensis* it is doubtful if there can be said to be any lateral apophyses, the ventral structure having more the appearance of being the ventral plate of the sternite itself, from which the lateral portions have receded. As, however, *adenensis* and its subspecies *amenophis* are alone in showing this formation and are otherwise fairly close to *geron* and *struvei*, it seems simplest to retain the three species in one group for the present. The same applies to *phlomidis.*

The characteristic facies of the species of these two groups are of great interest, though somewhat involved. There are two main characters attaching to both groups: (1) the size of the white markings on the upperside of the fore-wing, (*a*) either small with a strong tendency to become obsolete, or (*b*) very large, square and fully present; and (2) the direction of the median band on the underside of the hind-wing, (*a*) uniting with the 2nd white spot between nervures 7 and 8, or (*b*) uniting with the 1st white spot between nervures 7 and 8. (The first spot being, of course, that nearest the margin of the wing.) Unfortunately neither of these characters will cover all the species of either group, so to diagnose them one has to employ a combination of the two. This suggests that further subdivision is wanted. Such subdivisions, as previously noted, are indicated by the form of the harpe, which would separate *phlomidis* from the *sertorius* group, and *adenensis* from the *geron* group. This division would not, however, solve the difficulty of superficial characterisation, for though helpful so far as the *sertorius* and *phlomidis* groups are concerned, we would be unable to characterise the *adenensis* and *geron* groups. The discovery of further species of the latter group may in course of time necessitate this subdivision, and also provide fresh characters which are not evident in our present limited material.

Male armatures of *[illegible]* and *Sloperia*. Non-Europeans.

1. *P. [illegible]*
2. *P. adenensis*
3. *P. [illegible]*, race *amenophis*
4. *S. [illegible]*
5. *S. [illegible]*
6. *S. [illegible]*

The two main groups which have been defined are best characterised as follows:—

Geron group: Large, square, white markings on upperside fore-wing; median band underside hind-wing connecting with 1st white spot between nervures 7 and 8.

Sertorius group: A. Small white markings on upperside fore-wing.
- (*a*) Median band underside hind-wing connecting with 1st white spot between nervures 7 and 8. (*galba.*)
- (*b*) Median band underside hind-wing connecting with 2nd white spot between nervures 7 and 8. (*sertorius, therapne, ali* and *orbifer.*)

B. Large, square, white markings on upperside fore-wing.
- (*b*) Median band underside hind-wing connecting with 2nd white spot between nervures 7 and 8. (*phlomidis.*)

This illustrates the dangers of forming any groupment of Hesperid species upon superficial characters alone. In the present case, had this been done, whichever character was chosen, the result would have been equally incorrect. If the size of the markings on the fore-wings were taken it would place *phlomidis* in the *geron* group. Likewise, if the direction of the median band on the underside of the hind-wing were taken, it would leave *phlomidis* in the *sertorius* group, but place *galba* in the *geron* group. Most writers in the past have placed *phlomidis* with *geron*, the similarity between the two being very striking. If, however, the design of the underside of the hind-wing of *phlomidis* be looked at in detail, and not in general, it will be noted that the character of the median band is typical of *sertorius*, etc., and not of *geron*. This fact is of great interest. *Phlomidis*, both structurally, and in the design of the underside, superficially, belongs to the *sertorius* group; yet in spite of this its appearance is so suggestive of the *geron* group species that it has been habitually classed with them. There seems to be only one reasonable explanation for this mistake, and probably much of the perplexing similarity found between so many species of *Hesperia* can be accounted for in a similar manner, *i.e.* mimicry. If some specimens of *phlomidis* and *sertorius* are examined closely, it will be seen that the extra white spots on the fore-wing of the former are often present on the underside of the fore-wing of the latter, and almost always present in *galba*. Although one would not have thought it, a mere magnification of the existing markings of *sertorius* would give one a form similar to *phlomidis*. On the underside, a pale shade of ground-colour and the expansion of all the white markings have led to the same effect. In the *sertorius* group (excluding *galba*) the arrangement of the markings on the underside of the hind-wing between nervures 7 and 8 is: 1st spot rising from the wing margin, white, followed by a space of the ground-colour, then the second white spot with which the median band connects, and then another space of ground-colour. In the *geron* group this alternation of markings is reversed, beginning with a space of the ground-colour next to the wing margin, followed by the first white spot with which the median band connects, and so on. On looking at *phlomidis* it will at once be seen that the position of these spots is as in *sertorius*, so that the *geron*-like appearance is entirely artificial and not the result of similar design. The similarity in *phlomidis* is heightened by the presence in that species of a dark spot of the ground-colour within the first white one, which helps the general illusion by suggesting that the white spot is not connected to the margin, although some part of it always is. It is

an exactly parallel case to the apparent likeness of *H. sidae* and *R. antonia*, on the underside, on which we give some notes by Chapman (see under *sidae*). In the present case we can only agree with Chapman's conclusion in the latter, that nothing but mimicry could have produced such remarkable identity of effect without actual identity of markings. The distribution of *phlomidis* further supports the theory of mimicry.

The case of *galba* is equally remarkable, retaining as it does on the upperside the fine markings of the *sertorius* group, but with the extra basal spots typical of the *geron* group. On the underside the median band connects with the first white spot between nervures 7 and 8, while the alternation of markings between those nervures is also as in the *geron* group. The resulting effect is a considerable likeness to the Egyptian *amenophis* on the underside, while the upperside shows some likeness to *adenensis*. Anatomically *galba* cannot be removed from the *sertorius* group, even if that group were further divided it must remain with *sertorius*, *orbifer*, etc., yet in the design of its underside it is absolutely dissimilar to its nearest allies. It is difficult to say if the approach of the characters of the underside to *amenophis* is, in effect, sufficiently close to be the result of mimicry; also, the change in the marking is far greater than that undergone by *phlomidis*. The occurrence of *galba* in Arabia would seem to admit of the possibility of mimicry, and one must not overlook the possibility that perhaps we are unacquainted with the true model, for many species at present unknown to science may exist in that country.

V. Explanatory Note on Varietal Forms, Subspecies, etc.

Throughout this monograph the terms subspecies, form and race have been used in a slightly different sense from that which is usual; so a brief definition of these terms is necessary, in order to avoid misunderstanding.

(1) Subspecies. A constant race differing from the type in both sexes, occurring locally and completely excluding the type.

(2) Form. A constant race differing from the type in both sexes, occurring in the same locality, but replacing the type regularly at given seasons. (A true seasonal form is an extremely rare phenomenon among the Hesperids.)

(3) Race. A constant variation differing from the type in one or both sexes, occurring with the type.*

In view of the proposed alteration in the international Code, excluding names of a lower rank than a subspecies from any status in nomenclature, it becomes more than ever essential to make some such distinctions as those suggested above, between the degrees of variation which prevail in all forms of animate objects; for, as the names of minor degrees of variation will no longer be able to claim perpetuation by priority, we shall get an ever-increasing flood of so-called subspecific names, numbers of which will have no real claim to the rank of subspecies, in its true sense, *i.e.* the highest development of specifical characters which it is possible for some varietal form of a species to attain (without actually being separated from the species) concurring with the entire elimination of the typical form from the units of the race. The latter provision is in my opinion absolutely essential to the subspecific standing of a

* The term "variety," which has been used occasionally, is merely employed to express *any* deviation from the type, and not as a definition of an exact degree of variation: "aberration" is employed for any variety too inconstant in development or of too sporadic occurrence to be classed as a "race."

1

2

3

5

4

6

Male armature of *S[illegible]* and *R[illegible]*. Non European species.

1. *S. mohammed*
2. *S. [illegible]*
3. *S. [illegible]*
4. *R. st[illegible]*
5. *R. albita*
6. *R. prote[illegible]s*

race, for it is obvious that the final transition to a new species must be preceded by a period when the old type is completely superseded, which period must be regarded as the supremest development of variation possible within the limits of a species, *i.e.* the true subspecies. It is also probable, that *natural* reversion is impossible after this stage has been attained. Of course it may be said that it is impossible to define any degrees of variation in a useful manner, but of this I am not at all sure; and it seems quite possible that future work may throw much fresh light on this subject. That one cannot define absolute distinctions between subspecies and race, and race and aberration, is obvious, each being but a continuation of the other; but in spite of this there is much that goes to prove that in the natural order of evolution such definite stages do exist. Briefly put, one would probably be correct in saying that an aberration is an indefinite demonstration of the existence of variation-compelling factors; that a race is the outcome of variation—as represented by the aberration—controlled by selection; and that a subspecies is the ultimate development of a race, prior to its final separation from the parent species. Much more might be said on this interesting subject, but it would be unnecessary here. The chief object in studying variation must be to separate the true subspecies from the mass of minor varieties, and to establish it in its position of primary importance in the evolutionary scale, as the forerunner of the species to come. It is, of course, also important to get a knowledge of the variations which led to the development of the subspecies, and this is best done by separating and defining as many of the preceding stages as possible. That these stages are often difficult to define precisely is no reason for neglecting them, and if more attention had been given to this matter in the past, we should not have heard so many eminent entomologists questioning the possibility of gradual evolution. It is worth noting, that the cases in which these stages in the evolution of a subspecies are sharply separated have been made a basis for the argument of what is called discontinuity of variation, while the other cases (by far the most numerous) where there is no sharp division between aberration and race, and race and subspecies, have been passed over, and made apparently non-existent, by the fatal habit of covering all forms of variation by one term.

There is a strong tendency among workers in Mendelism to assert that there is no real continuity in variation. The fact that in some of the well-known cases of mimicry the mimetic forms have been found to breed true, without intermediates, is held to be a proof of this. Also, in certain cases in which intermediates do exist, in such a conspicuous manner as to force themselves into notice, it has been found by experiment that there is nothing contrary to the Mendelian principles in these cases. So far, however, it seems to have been overlooked that in the experiments which have led to these results, one method has always been followed, viz. the crossing of one extreme form with the other. This, of course, presupposes the existence of the two extremes in the first instance. For this we have no proof, and observations in the field lead one to the opposite conclusion. The slight variation is the universal rule, and pronounced forms the exception. One cannot accept, then, without very definite proof, that the extreme form originated before the slight variation; if it had, it should be of at least as universal occurrence as the aberration, which it is not. Further, how could we account for those cases in which a species throws numerous slight aberrations but no pronounced or extreme form?

The fact that one can breed transitional forms from the extremes, in a

manner which is in accordance with the Mendelian laws, in view of what we see in nature, goes rather to prove that the slight transitions are the component elements of the extreme, and that they therefore are the basis of its construction, and preceded it, than that they originated from it. Again, the fact that the famous *Hypolimnas mima* and *wahlbergi* have been bred from one batch of eggs without intermediates, is no proof that the intermediates never existed; it merely shows that there is perfect segregation between the two forms *now*, but it leaves us in absolute ignorance as to whether this was so or not five thousand years ago.

Whether the slight variation is a Mendelian factor or not is questionable; but, if we acknowledge the existence of continuity in variation, it seems reasonable to suppose that, to start with, it is not, but that, as it develops, it becomes so. Two facts concerning it remain certain: it is the most universal and frequently occurring form of variation, and it is unquestionably a heritable quantity and is handed on from generation to generation.

I do not think more need be said to show how desirable it is to endeavour to classify, as accurately as possible, the varying degrees of variation. I therefore adopt the terms already described, and have endeavoured to apply them with as much accuracy as possible in the systematic part of this work. I do not by any means wish to maintain that the tabulation of variation I have drawn up cannot be improved on, but it may serve as a beginning, and the mere fact of the difficulties it involves in application may prove a help in checking the multiplication of unnecessary names. Some well-known Continental writers use the term "race" to cover both subspecies and race, as I have described them; but many of their races have been described from single specimens! Also, their seasonal forms are often indistinguishable from each other, so that the names given to them apply only to dates, and not to distinctive forms. This disastrous custom can never be checked until it is universally accepted that descriptive prefixes represent certain values, and must be used in as accurate a manner as possible. Were this so, the writer who scatters names like falling leaves in autumn (invariably with insufficient descriptions) would soon find that he could not continue on such lines, if he wished any scientific publication to accept his work.

VI. Variation in the Male Genital Armature in the *Alveus* Group of the Genus *Hesperia*.

The subject of variation in the genital armature is one which is rather ignored by anatomists, as a whole; and particularly when considering very closely allied species, such as we have in the genus *Hesperia*, the temptation to assume that the structural features of the genitalia are invariable is very great.

In the course of a careful study of the subject, when working out the classification of the Palaearctic Hesperiinae, one became impressed by the fact that a good deal of individual variation was to be seen in these structures; and to turn away from it was only to increase the difficulties of any future worker in this line. There is, however, nothing so very disconcerting or unnatural in the fact of the existence of such variation, nor does it in any real degree reduce the value of these organs as taxonomic characters. It may probably be said that all zoologists of the present time believe in the evolution of species from previously existing species; and the mere acceptance of that theory is, in itself, an acknowledgement of the existence of variation

J. bile S P r [illegible]

Male armatures of *Reverdinia*, *Tuttia* and *Hesperia* Non European species

1 *R proteus* race *prometheus*
2 *T gijis*
3 *T nobilis*
4 *H rurula*
5 *H alveus* s sp *ilicrsis*
6 [illegible] *sifani is* Also European

in the structural as well as the superficial elements of a species. Indeed, one might question, with reason, the possibility of the existence of any such thing as true stability of structure in animate organisms.

Of course this structural variation is only very slight when compared with superficial variation, which is an essential point to remember when considering it. That this must be so is obvious, when we think of how slight the structural differences between many species are; indeed, so much so is this the case, that we probably often fail to recognise it. Such slight anatomical variations from the type must, almost completely, be caused by embryological forces, and cannot be much affected, as external characters are, by the conditions of existence; and for their continuance, they must be entirely dependent on heredity. Further, in cases where they have been developed into racial characteristics, it can only have been through the medium of heredity, controlled by natural selection, working on some coexisting factor, which factor very possibly might not occur in more than a small percentage of the specimens exhibiting the anatomical variation. When this fact is fully appreciated, it will be seen that, although such variation may only be of a very minute character, it must have been of fairly frequent occurrence in the past, or we should undoubtedly find many distinct species with absolutely similar genitalia. We can also understand that there should not be any great distinctions in the genitalia between species and species in groups (or genera) of recent origin.

In the genus *Hesperia* this structural variation is most apparent in the *alveus* group, and in this fact, and in the presence of so many very closely allied species, I think we have a distinct indication that the species of this group belong to some of the most recent forms in the whole genus. Among the other genera of the tribe it is only in the genus *Tuttia* that we find a corresponding tendency to variation, and there it is of less frequent occurrence. The many eastern species and races, showing very close affinities to *alveus*, are some of the most difficult forms to classify; and most of the structural distinctions relied on by Reverdin for identifying them are of a slight character, and, as will be shown presently, all of these distinctive characters occur occasionally in typical *alveus*, in a more or less rudimentary form. It seems to me, therefore, that we cannot know too much of, or observe too carefully, the extent and frequency of occurrence of such variations, and that by doing so we shall get a far greater insight into the affinities of these insects than would otherwise be possible.

In the European species of this group, *alveus*, *armoricanus* and *foulquieri*, the cuiller and lateral apophyses of the 10th sternite show the most variation, the style and stylifer being also slightly variable. In *armoricanus* the cuiller is smaller than in the other two species, of more even outline, and its dorsal termination or apex is sharply pointed; in *alveus* the cuiller is more expanded, and its dorsal elevation is slightly flattened and the apex gently rounded off; while in *foulquieri* it is considerably expanded, of much more uneven outline, and the apex still blunter than in *alveus*. Variability in the shape of the cuiller and the formation of its apex occurs occasionally in all these species, but apparently with far greater frequency in *alveus*; or it may be that we are led to suppose this to be so, on account of a greater number of specimens of that species and its races having been examined. Reverdin has made 174 microscopic mounts of it; I have mounted 57 specimens and examined many others without mounting them, and Chapman mounted at least 20 specimens. This gives one in total a considerably greater material to work on than we have of most species.

Thus we find *alveus* with a slightly pointed apex to the cuiller. Chapman noted a specimen from Vissoye (Valais) with a pointed apex, though not so pronounced as in *armoricanus*; and a second from Carinthia. These forms are rare. A blunter apex than normal is of much commoner occurrence, resembling *foulquieri* fairly closely. I have two such specimens from Kandersteg and one from Follaterre (Valais). Another variable feature of the apex is its armature of spines. In *alveus* this usually consists of a small cluster of more or less equal-sized spines; in *foulquieri* the arrangement is varied by the presence of one or two strong teeth bearing spines at their termination, both arrangements being common to *armoricanus*. In *alveus* the spines are not infrequently completely absent. This is practically always so in the race from the Pyrenees, but also occurs occasionally in many other localities. I have 8 of these spineless specimens (apart from Pyrenean ones) from Italy, Switzerland, France and Spain. Reverdin has 11, from one of which fig. 3 on Plate X was taken, and one similar specimen of *armoricanus*, which shows that species to be more constant in that respect, as I have not seen an example of it, and Chapman did not mention it either. Reverdin's specimen was the only one he found in 106 mounted examples. *Foulquieri* has not been found without its armature of teeth and spines, in spite of the fact that it shows much variation in the number of these teeth and spines, and that these are frequently different, both as to size and number, on the two clasps of one specimen. The proximal edge of the cuiller, between the apex and point of junction with the harpe, is, in *alveus*, practically vertical, while in *foulquieri* it slopes forwards towards the harpe, and in *armoricanus* backwards away from the harpe. This feature is subject to much variation in *alveus*, most frequently inclining towards *foulquieri* and only extremely rarely approaching *armoricanus*. The individuals which resemble *foulquieri* in this way often have the apex blunted as in that species too. This free portion of the proximal edge of the cuiller is normally shorter in *foulquieri* than in *alveus*, owing to the formation of the apex. One sees, however, fairly frequently, specimens of *alveus* in which it is of exactly the same form and length as in *foulquieri*. This feature is very noticeable in the Pyrenean subspecies of *alveus* (Pl. XLV, fig. 2). This subspecies gives one quite the most perfect example of transition between two species, both structurally and superficially, which has so far come to my notice among Lepidoptera. The form and position of the apex of the cuiller, which is typical of this subspecies, is nearer to *foulquieri* than *alveus*, but the apex is almost always quite without spines: in only one case have I seen a specimen in which a few were present. Further south, in Spain, we find another subspecies, also showing this approach to *foulquieri* (Pl. XLV, fig. 1). Another feature of the Pyrenean subspecies is an appreciable ventral and distal expansion of the cuiller; in some specimens the expansion is in one direction only. This variation is somewhat rare. Among Chapman's mounts there are several examples which show it in a pronounced form; I have 4 among my own preparations, and Reverdin has one example. The lateral apophyses in this subspecies are also variable, occasionally having the long slender supports as in *foulquieri*, but more often varying in other directions. The Pyrenean subspecies is not the only form in which one finds specimens of *alveus* developing a somewhat *foulquieri*-like expansion of the cuiller, such examples being found, rarely, anywhere with the typical form. I have one example from Follaterre (Valais) and one from Kandersteg. Chapman recorded one from Eclépens, and Reverdin has 6, 5 of which come from the Grand Saléve, near Geneva. I also have another very remarkable form, on the

same line of variation, but not approaching any existing species; for the expansion of the cuiller has taken place upwards, from the dorsal edge. The specimen came from Kandersteg. Yet one more variation of the cuiller has been noted by Chapman. In this there is a curious flattening along the lower posterior aspect of the cuiller. Chapman noted that a tendency to this flattening was not so rare, but in a pronounced form he had only found one example, a specimen from the Maderaner Tal, which was, he remarked, "nearly identical with the formation in *speyeri*." This feature is plainly seen in the photograph of *speyeri* (Pl. VI, fig. 1), in which species it is the normal formation. In *reverdini*, too, one of Reverdin's specimens exhibits a tendency to this flattening (Pl. VI, fig. 2). Among my specimens of *alveus* I have 9 such examples: one with a very pronounced flattening from the Gemmi Pass, another not quite so pronounced from Verossaz (Valais), and one from the Pyrenees. Another very remarkable specimen, from Lenzerheide (Grisons), has this posterior flattening developed on both the upper and lower aspects of the cuiller simultaneously. This specimen further has the distal edge of the lateral apophyses straight, and the concavity distinctive of *reverdini* in the stylifer, two interesting forms of variation which will be considered later. I have a second similar example (with the double flattening) from Rivoli near Turin, and three others with the lower flattening: one from the Altai, one from Follaterre, and one from Göschinen. The 9th example is remarkable in that it is the upper posterior aspect which is flattened, just the converse of the *speyeri*-like examples. Reverdin has an analogous form of *armoricanus* from Hyères, and 3 examples of *alveus*, one of which is illustrated on Plate X, fig. 4, and came from Orange (Jura Bernois). On the same plate, figs. 5 and 6 represent two other rare forms. Figure 5 is an extraordinary malformation, which is included to illustrate what remarkable formations can arise, from unknown causes. Figure 6 shows an example with a very short straight style. This is a rare occurrence. Reverdin has two other specimens and I have one. To return to the formation of the cuiller. In *armoricanus* it is apparently not at all so given to variation as in *alveus*, but the apex sometimes tends to be blunted, or of alvean formation. Chapman notes a Corsican specimen from Bastelica, with the apex "bluntly pointed on one side, and on the other shortened to a double point," and a Russian example from Tula, with the apex rather rounded. The examination of this specimen evidently left the Doctor in some doubt, for he notes: "possibly really *alveus*, as the antistyle is broad and the lateral apophyses have the upper margin straight or even slightly concave, though they are short and thick. I rather incline to place the specimen with *alveus*, but it is puzzling." The specimen appears to form a very perfect transition to the race of Asia Minor, which Reverdin has named *persica*, and in which the shape of the cuiller, style, antistyle, and lateral apophyses are similar to *armoricanus*, but the apex of the cuiller has not the sharp point and is more suggestive of *alveus*.

In *foulquieri* there are only very slight variations to be found in the form of the cuiller, which do not in any degree alter the characteristic formation peculiar to that species. Reverdin has made 30 mounts of *foulquieri* (with *bellieri*) and found them perfectly constant.

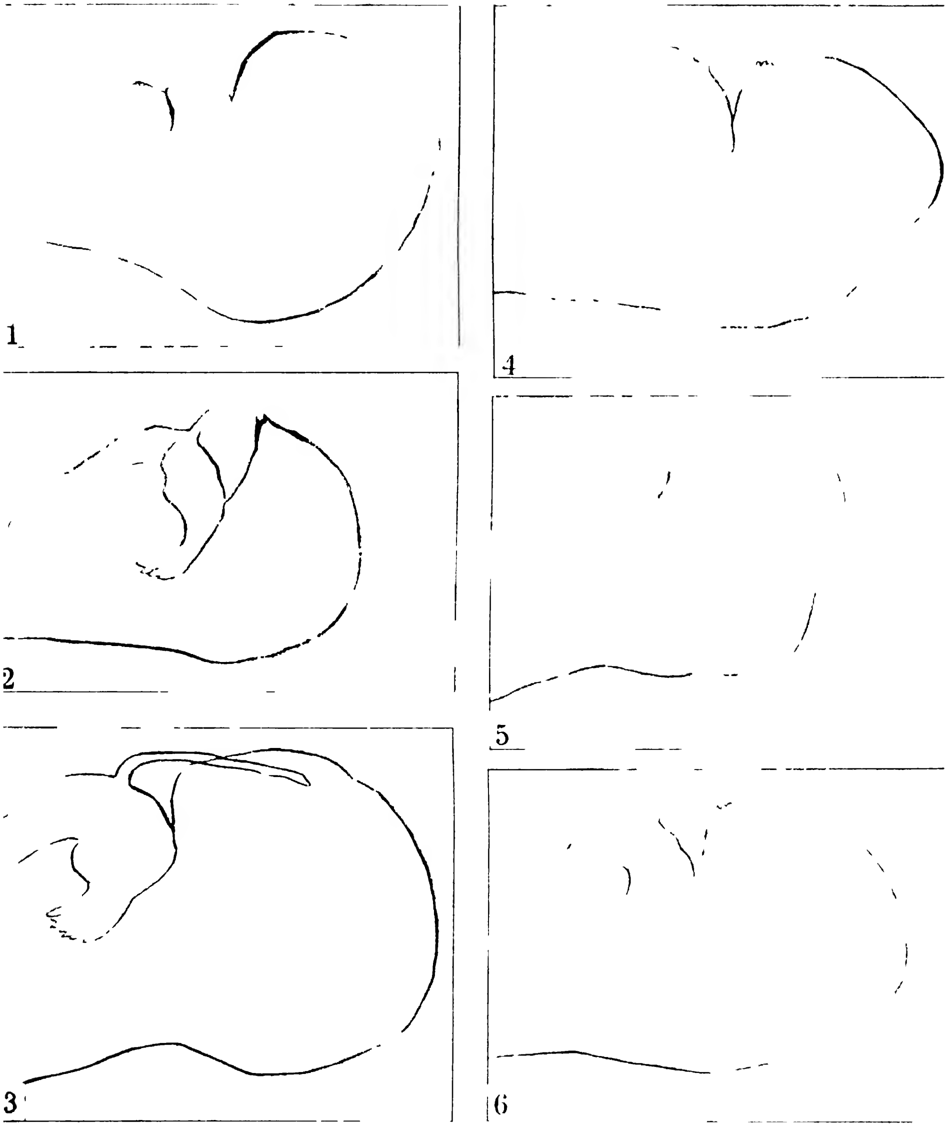
The lateral apophyses, next to the cuiller, appear to be most variable; again particularly so in *alveus*, and rarely in *foulquieri* and *armoricanus*. The principal lines of variation in *alveus* are the length of the apophyses and the degree in which their distal margins are straight or upturned at their extremity, the latter giving the normal concave aspect. I do not think the distal edge is

ever convex in *alveus*, but in his notes on an aberrant form of the apophyses in *armoricanus* Chapman mentions a specimen with the distal margin of the apophyses "straight or even slightly concave," and adds, "a form that is closely approached sometimes by *alveus*." I possess two specimens of *alveus* showing this form, one from Lenzerheide (Grisons) with the distal edge of the apophyses quite straight, and one from Verossaz (Valais) in which they are very nearly so. Three other specimens of mine from the Pyrenees have practically straight edges to these processes. The length of the apophyses, as already noted, is very variable. Two Asiatic species, *speyeri* and *schansiensis*, have long, very highly developed apophyses. In the latter species this character is the main point of structural difference between it and *alveus*. In *speyeri* they are not quite so extended, being more or less intermediate between *alveus* and *schansiensis*. Chapman noted in connection with this, that it was "not uncommon" to find specimens of *alveus* in which the length of the apophyses was hardly less than those in *speyeri*, as "in ordinary *alveus* there is very great variation in the length of the apophyses, while some specimens of *speyeri* approached *schansiensis* very nearly in this respect."

Another very interesting form of variation is to be seen in the stylifer. This part, in the *alveus* group, is roughly speaking a square piece, from two opposite angles of which extend the style and antistyle, whilst of the other two the distal is attached to the cuiller, and the proximal is rounded. The proximal margin, which extends from the base of the style to the base of the antistyle, is in *alveus* strongly convex, and in the middle of its length the convexity is greatest, this producing the proximal angle just alluded to. In the centre of the angle, or sometimes a little below it, one occasionally finds a concave indentation, which varies in degree as to the sharpness of the indentation and the extent of the concavity. This feature is seen in its most pronounced form in *reverdini*, where it is the normal structure and the character relied on by Reverdin to distinguish that species from *alveus*. Chapman noted a number of examples of this form among his preparations of *alveus*, and a few in *armoricanus*. His notes on *alveus* give the following :—

1. A specimen from Bourg St. Maurice "has a very distinct concavity."
2. One from Carinthia "has a slight concavity."
3. A specimen from Gavarnie in which the convex margin is flattened but not concave.
4. A specimen, locality unknown, with a "decided but not deep concavity."
5. A specimen from Courmayeur, with a "shallow concavity."
6. A specimen from the Gr. Glockner, with the angle flat on one side and slightly concave on the other.
7. A specimen from Tragacete, with a concavity "between the proximal angle and the antistyle."
8. A specimen, locality unknown, in which the proximal angle of one stylifer has a slight concavity, the other being normal.
9. A specimen from the Grand Salève, with a "pronounced concavity."
10. A specimen from Chamonix, with a "concavity rather to the lower side of the angle."
11. A specimen from Pontresina, "stylifer with the *reverdini* concavity."
12. Another specimen from Pontresina, "with the concavity not so well developed as in the last specimen."

It is interesting to note from what widely separated localities the above twelve specimens come. I myself have another twelve specimens of *alveus*



J. Bale, S. & D., Ltd. *Del. J. L. Reverdin*

Abnormal structural formations in *Hesperia alveus* and *H. armoricanus*

1. *H. alveus.* Concavity in stylifer.
2. *H. armoricanus.* Slight concavity in stylifer
3. *H. alveus.* Style of very abnormal length.
4. ,, ,, Lower posterior flattening of cuiller
5. ,, ,, Malformation of clasp
6. ,, ,, Style extremely short.

with this *reverdini* concavity showing in various degrees of development. They come from widely separated localities in Italy, Switzerland, Austria and the Altai. I also have one specimen of *foulquieri* from Digne in which there is a very slight indentation in the angle of the stylifer. This is the only specimen of this species, showing this form of variation, that I have heard of.

Chapman further notes several examples of *armoricanus* which have a "slight but obvious concavity in the stylifer," and that "precisely the same concavity occurs in *speyeri* apparently as the normal structure." This must have been a slip on his part, for among his mounts of *speyeri*, only four in number, one was a ♀, one a perfectly typical ♂, *i.e.* without any concavity but with the proximal angle flattened, and two showed a very slight concavity. In my own mounts of *speyeri*, only three in number, one has a very slight concavity, and in the other two the angle is flattened but in no sense concave. Reverdin has four mounts of *speyeri*, all of which are typical, *i.e.* with the proximal angle flattened as in our photograph (Pl. VI, fig. 1). He also has twelve mounts of *alveus* all showing a slight concavity in the stylifer, but this, he remarks, is infinitely less pronounced than in *reverdini*. He also possesses nine examples of *armoricanus* with a slight concavity, one of which, from Digne, is more pronounced than the specimen we illustrate (Pl. X, fig. 2), but all the others are less so. I have only mounted some twelve specimens of *armoricanus*, but I have examined a considerable number more without coming on any of this form, which is evidently rather rare in the species. One of Reverdin's specimens of *alveus* is figured on Plate X, fig. 1. The concavity in it appears to be very pronounced, but it must be remembered that the figure is magnified at least 35 times. Another form of variation occurs in *alveus*, but is apparently extremely rare. It affects the uncus. Chapman remarked that very rarely he had observed specimens in which the uncus tends to be divided into two pieces, after the manner of that structure in *malvae*, the tendency, however, being very slight and only affecting a short portion of the end of the uncus. I have only seen one such specimen myself, and in it the division is only noticeable at the extreme tip of the uncus. The specimen came from Larche.

This completes the list of variations in the male armature of the species of this group which have come to my notice.

I have previously remarked that several of the characters on which Reverdin relied for his determination of various Asiatic species of the group were known to occur rarely in *alveus*, and it was that fact which led to the collection of the details which have just been given. I do not think, however, that there are many lepidopterists who would have thought it possible that so much variation could have existed.

Thus we have seen specimens of *alveus* with very long apophyses, approaching very nearly those processses in *speyeri*, which in turn produces individuals closely resembling *schansiensis* in this character, which is the one by which Reverdin distinguishes the latter species (*schansiensis*) from *alveus*. Again, examples of *alveus* present various characters typical of *foulquieri*, such as the extension, ventral or distal, of the cuiller, and the shape of its apex. Specimens of *armoricanus* also show the latter character, while *foulquieri*, *alveus*, *armoricanus* and *speyeri* all develop the concavity in the proximal angle of the stylifer, on which peculiarity the specific distinction of *reverdini* rests. The latter in turn seems to incline to the posterior flattening of the cuiller that characterises *speyeri*, as do *alveus* and *armoricanus* also. Further, *alveus*, on occasions, develops both these characteristic features of stylifer and cuiller simultaneously.

Faced with this rather surprising list of facts, the first question which naturally comes to one's mind is the old one: What is a species? It is followed by a possibly even more difficult one: How can we define in visible quantities an invisible element? No final answer can ever be given to the latter question, for the distinctions that we can apply between species and species, and variety and species, will be of ever changing and unequal values, in exact relation to the maturity or otherwise of the species which compose the groups or genera under consideration. It is, all the same, a question which no writer of a work on the Hesperids can hope to be able to avoid. The characters which we think necessary for the definition of specific distinction in the subfamily HESPERIINAE will be dealt with separately, but it may not be out of place to refer here to that aspect of it raised by the structural variations under consideration.

It is well known that in large groups including numerous and closely related species the distinctions between species are much less marked than in smaller ones composed of but few species, and often distinctions which are only regarded as denoting a variety or race in the latter will be regarded as of specific value in the former. The cause of this must be largely a matter of the maturity of the units composing the group. The large group has become large because the conditions of the period were, or had been, favourable to the increase of varieties and subspecies of the species composing it. Accepting the theory that the true subspecies is the forerunner of the species, we have in consequence an increasing number of species, as nearly related as is possible, sometimes even with the intermediate forms between the new species and the old still discernible. This is precisely the condition in which we find certain groups of the genus *Hesperia* at the present time. Few, if any, of the other genera of European butterflies show us such a complete and perfect illustration of the evolution of species. We therefore must not look to find, when trying to classify such forms as those which compose the *alveus* group, any very extreme distinction between species.

Reverdin, after his long and searching studies of the species of that group, considers that *alveus*, *foulquieri*, *armoricanus*, *speyeri*, *reverdini* and *schansiensis* are distinct species. *Numida*, *iliensis* and *sifanicus* he retains (doubtfully) as races of *alveus*, which may be distinct, and *persica*, as possibly distinct, but more probably only a race of *armoricanus*. Now, remembering this, let us note seven points which our review of the anatomical variation has given us.

(i) The distinctive structural characters, which are constant in *foulquieri*, *armoricanus*, *reverdini*, *speyeri* and *schansiensis*, may all occur on occasions, in a rudimentary condition, in *alveus*.

(ii) The alvean formation has never been found in any of those species.

(iii) The distinctive characters of *speyeri* and *reverdini* appear in *armoricanus*.

(iv) That of *reverdini* (once only) in *foulquieri*.

(v) Those of *reverdini* and *schansiensis* in *speyeri*.

(vi) That of *speyeri* in *reverdini*. (Very slight but suggestive.)

(vii) As many as three of these distinctive characters may appear simultaneously in *alveus*.

From these seven facts we can come to two conclusions with tolerable certainty. First, that *alveus* is undoubtedly the parent species of *foulquieri*, *armoricanus*, *reverdini*, *schansiensis* and *speyeri*; for it tends to produce,

aberrationally, the structural characteristics of all five, none of which produce the characters of more than two (and never those of *alveus*); and, second, that these five species are distinct from *alveus*.

I have no doubt that there are lepidopterists who, on the strength of the above facts, might suggest classing these five species as races of *alveus*, merely because the distinctions are slight; their appearance in *alveus* would be taken as diminishing their specific value. That line of argument, however, does not appeal to me at all. On the contrary, when some structural character, which only occurs on rare occasions in a certain species (as the *reverdini* concavity in the stylifer of *alveus*, which is the most frequently occurring form of structural aberration we have found, but yet was present in only 36 specimens out of 253 mounted specimens, and at least another 50 unmounted ones, which I examined myself), and is then a deviation from the normal structure of that species, is produced constantly and in a more developed form in some other race, otherwise similar, it shows that the latter race has been drawing away from the former. And the fact that the character has now become a fixed peculiarity, to the exclusion of the other formation, seems to me to prove that the race exhibiting it has come to, and passed, that undefinable point at the parting of Nature's ways, where the variety ceases and the species begins.

The data collected concerning *alveus*, *foulquieri* and *accreta* (the latter the Pyrenean subspecies of *alveus*, the full description will be found in the systematic part) gives one a very remarkable illustration of the evolution of a species. The formation of the cuiller and lateral apophyses in *alveus* and *foulquieri* is constant, though, as we have seen, in the former there is a tendency to produce variation on certain lines, *i.e.* similar to *accreta*. In this latter, the formation of these structures is very variable, standing between *alveus* and *foulquieri*, and may be more or less similar to either without attaining the true form of either. On the whole, Reverdin and I found more specimens approximating to *alveus* than to *foulquieri*, but Chapman obtained so many approximating to *foulquieri*, that he made the following note: "*alveus* from Gavarnie [i.e. *accreta*] is probably a form of *foulquieri*." To this we may add, that no specimen of *foulquieri* is known approximating (anatomically) to *accreta*, though, as was previously noted, specimens of *alveus* from widely separated localities do so. Further, *accreta*, while showing points suggestive of *alveus* in its superficial facies, is much closer to *foulquieri* in this respect. No more perfect illustration of the origin of *foulquieri* could be wanted. There are four main points in which the armature of *foulquieri* differs from that of *alveus*: the lateral apophyses; the outline of the cuiller; the apex of the same; the antistyle. Rudiments of three of these features occur occasionally in *alveus*, and they are always present in *accreta* in a more or less pronounced state of development, but of so variable a character that it was possible for two such experienced insect anatomists as Chapman and Reverdin to take different views as to which species *accreta* was closest to. The variable formations of *accreta*, somewhat more developed, give us the typical formations of *foulquieri*, which are never modified in such a manner as to produce a likeness to *alveus*. Can it be doubted from this, that *foulquieri* and *alveus* are distinct species, and that the former originated from the latter? *Foulquieri*, as we have seen, produces some anatomical variations, but not on lines towards *alveus*, while the unstable *accreta* plainly shows that it is still a form of the latter and can vary towards it, and does so to such an extent that there is sometimes no difference to be observed between them, and always a very

strong similarity, though at other times it approaches *foulquieri* in an equally marked manner. We must add, in regard to the note of Chapman's quoted above, that he had not mounted very many specimens of *accreta*, and these happened to be very *foulquieri*-like ones. Had he examined a greater number, there is no doubt he would have altered his opinion, for the large majority could not be taken for anything but *alveus*, and the *foulquieri*-like specimens, though suggestive of that species, could not be mistaken for it. The note is valuable, however, in demonstrating how similar to *foulquieri* some specimens of *accreta* can be.

Returning to the question of the specific standing of *foulquieri*, *armoricanus*, *reverdini*, *speyeri* and *schansiensis*, as distinct from *alveus*, I do not see anything in the structural variations we have been considering to cause us to doubt their specific separability, but whether *reverdini* and *speyeri* are absolutely distinct from each other is a more difficult question. Both species (possibly) develop the character which distinguishes the other from *alveus*. Enough material is not available, however, in the case of *reverdini*, to enable one to be sure of this, for the genitalia of only two specimens are known, but the one shown on Plate VI, fig. 2, has a slightly flattened posterior edge to the cuiller. Of *speyeri*, Reverdin and I have mounted, altogether, 11 specimens, one of which was a ♀. Out of the 10 ♂ examples, two showed a slight concavity in the stylifer, a high proportion out of so few specimens. It must be remembered, though, that as the proximal edge of the stylifer in *speyeri* is flat, and not angled, a much slighter alteration in form produces a concavity than would be required to do so in *alveus*. That these two species are very closely related is certain; but as both are unquestionably derived from *alveus*, they might be expected to show a certain amount of analogous variation. That two out of the ten known specimens of *speyeri*, however, should show a transition to the *reverdini* formation, and one of the two known examples of *reverdini* to that of *speyeri*, so strongly suggest that both are one form, that I should have felt obliged to class them so, but for the following consideration. In *alveus*, as we have already seen, the two distinguishing characters of these species not infrequently occur in one individual; of the twenty specimens I possess, showing one or other character, no less than six show both. It is absolutely certain, then, that the races which developed on these lines of variation would each have a strong tendency to both these forms; indeed, it might well be expected that a race in which both were constant would have been evolved. The fact that now one form consistently predominates in one race, seems sufficient proof that the races have been developing on divergent lines, and if they were not entirely distinct at present, it would only be a matter of time until they must become so. That they are so, however, at the present time appears probable; for even the limited material we have to work on shows that the peculiar character of each is, in its particular race, more strongly developed than when it appears in the other species.

In conclusion, it may be as well to point out that the unstable anatomical condition of *accreta* does not disagree with the constancy we have pointed out to be necessary to the subspecific standing of a race. Our remarks on that subject referred to the superficial characteristics of a race, not the structural. When the subspecies attains a structural distinctive constancy, it, of course, would no longer be ranked as a subspecies.

VII. The Characterisation of the Species in the Subfamily Hesperiinae.

The subject we have just been considering renders it necessary to define in detail the characters, or combination of characters, which circumstances have led one to consider necessary to specific standing in the family Hesperiidae.

There is a very strong tendency in the present day to rely altogether on the characters offered by the ♂ armature, and although such characters are without doubt among the most important we possess, their value is greatly increased by combination with other characters. In the family Hesperiidae the characters which are of greatest use in connection with those of the genitalia are the superficial ones of design; for the neuration on the whole is so generalised as only rarely to be of any appreciable value; and biological facts which are helpful, are, unfortunately, very seldom available. That I should rely on evidence offered by pattern (even in connection with structural details) may surprise some readers, for there is a growing inclination to disregard the simple features of shape and pattern (as distinct from colour) as being too variable to be reliable. We have, however, just shown that the genitalia can vary extensively, though not in a very pronounced manner. Yet when one considers how many factors can influence the superficial form of design in an insect, that cannot affect its structural formation, one cannot help wondering if, relatively, the variation existing in the structural elements does not show them to be of no greater stability than the superficial elements, only less exposed to unfamiliar influences. Be that as it may, the superficial facies of the insect are of considerable importance, and we cannot afford to neglect them, especially when dealing with the Hesperids.

To begin with, a moment's consideration will show that the superficial facies are more susceptible to surrounding influences and changing conditions than are the structural elements of a species, and in consequence, if a race is being influenced in a manner unusual to it, the superficial facies will be the first to bear witness to the fact. We see then that if two forms, originally one, are being influenced in different ways and are developing divergently, that in the earliest stages of such separation (the race and the subspecies) the superficial facies are already pronouncedly different. This being so, it follows that of two races, which from being one species have become two, the changed unit must show the change to at least as great a degree as the ordinary subspecies does. Bearing this in mind, we see that the amount of structural divergence which we consider necessary to specific distinction can be held to be a variable quantity, in proportion to the amount of superficial alteration observable. In instances where some biological data can be had, one obtains still greater liberty in regard to the question of the necessary quota of structural distinction. To take two examples. One would feel justified in accepting a form in which there was scarcely any superficial similarity to the type, as distinct, provided it also showed the least structural deviation constantly, but a form showing no superficial difference from another race, we should require to exhibit very pronounced structural peculiarities before we should care to admit it to specific rank. The above remarks might seem to imply that it would be impossible to have distinct species with exactly similar facies. This we know is not the case; distinct species do occur which are absolutely similar in appearance. Our observations merely go to show that such species have been evolved from widely different sources, and the superficial likeness has

been developed independently. Species can also undoubtedly occur with distinguishable facies, but similar in structure. The latter is certainly a much rarer occurrence, and one which is infinitely more difficult to deal with; and public opinion, although accepting in theory the principle that similarity in structure, while suggesting specific unity, is no definite proof of it, does not really stand by it in practice, and is apt to resent it when an author does so. The result of this is that one finds many writers who (without professing to do so) rely entirely on the genitalia, and do not trouble to consider the complementary evidence of the very essential superficial and biological factors.

All this may appear to the reader as being of a very elementary nature. It certainly is so, but in dealing with the Hesperids one has so little to work on, so few facts relative to their biology being known, that one cannot afford to disregard any data, no matter how elementary. One also wishes to demonstrate that no hard and fast rule can be applied as to what visible characters constitute a species and what do not, and to guard against the error of placing undue stress on any one character, or of falling into the habit of assuming that, because a certain structure is considered insufficient evidence in one case, it must be so in another. From this standpoint we will consider some of the most complex cases which occur in the subfamily HESPERIINAE, beginning with the genus *Hesperia*.

First of all, the familiar cases of *malvae* and *malvoides* may be referred to, not because there is the slightest doubt about these two being distinct species, but because they afford so remarkable an example of perfect superficial similarity in distinct species. As was noted before, there seems good reason to suppose that two such species cannot have originated from one form, but there is nothing to indicate how they arrived at their present similarity. Collectors of European butterflies are apt to overlook the point that *malvae* and *malvoides* do not stand alone in this remarkable resemblance. There is a third species, *pontica*, equally similar so far as the superficial facies are concerned, and equally distinct structurally. Chapman suggested that mimicry may have played a considerable part in the production of this similarity, and remarked that the fact that the three species inhabit distinct areas does not hinder this theory, for it is more than probable that their common enemy would be distributed over the whole region. One must also remember that although in Europe *malvae* and *malvoides* do not actually overlap, they come extremely close to one another in certain localities; and *pontica* and *malvae* may very possibly coexist in parts of Asia Minor, and possibly *malvoides* also, for our knowledge of the eastern distribution of these species is very fragmentary. Of their affinities, *malvae* and *pontica* show connection with *melotis*, in the remarkable form of the lateral apophyses, while *malvoides* in this detail is clearly nearer to *onopordi*. *Melotis*, *malvoides* and *pontica* show distinct eastern affinities in the form of the harpe and cuiller, modelled on the lines of the formation we see in *thibetana*. Thus, although we can trace the common origin of all three species, it is quite evident that our two European species are descended from different branches of that original parent race.

Another pair of European species has been the subject of much argument in regard to their specific standing, namely, *carlinae* and *fritillum*. It has for many years now been practically certain that these two are two good species, but only a few years ago Chapman admitted that he still had some doubts on the subject. In this case we have two forms with specialised habitats, one southern and lowland, and the other more northern and alpine. This, of course, while suggesting some distinct inherent nature, lessens the value of

such superficial distinctions as the insects show, as these differences might only be the result of the different habitat; but it does not lessen it quite as much as if the separation were enforced (as in the case of island species) instead of selected. We see species like *serratulae* and *alveus*, which have both alpine and lowland habitats, exhibiting slightly different facies more or less typical of the altitude they inhabit, but we also see *malvae* and *malvoides* which show no change of facies from sea-level to 7000 feet. Therefore, in the case of decidedly pronounced and constant facies (distinct apart from coloration) corresponding with the altitude of the habitat, we can safely attach considerable importance to that fact. It may be further noted that the facies of *alveus* and *serratulae* are not really exclusive to one altitude (except in the case of a certain race such as *alveus* race *ryffelensis*), but only tend to occur more in one than the other. The facies and habitats of *carlinae* and *fritillum* may then be accepted as valuable data, to which can be added the characters of the genitalia. The latter need not be described here, as they will be dealt with at length in our systematic part. Up to the present, it has been maintained that the formation of the lateral apophyses alone distinguished these species, which is quite sufficient reason to explain Chapman's doubts as to their specific value, for the apophyses are extremely variable. The form of the subharpal plate, however, and its position, is absolutely distinct in the two species, and leaves no further doubt in the matter, as anyone who looks at our photographs on Plate XXXI will see. Passing to *alveus* and its allies, we come to some interesting questions. In Europe we have *armoricanus* and *foulquieri*, but these are so distinct that they need not be mentioned here. The African species *numida* is in a decidedly more questionable position. Its facies is constant, and easily distinguished from *alveus*; but it shows no structural difference. Its segregation from the latter is complete, but enforced, and, further, its characteristic facies occur aberrationally in *alveus* throughout its range. We should in these circumstances have retained it as a subspecies of *alveus*, but for the following considerations. First, its specialised habitat and enforced separation have already affected it to so great an extent as to develop what was a rare aberrational character into a permanent form that has superseded the type; and this change is one of form and shape. Second, *numida* is double-brooded. The latter fact is of considerable importance. *Alveus*, throughout the whole region it inhabits, a very large region including widely different climates, is absolutely single-brooded. In Italy and southern Spain, the most southerly locality it occurs in in Europe, it is just as completely single-brooded as at an altitude of 6000 feet in the Alps. *Armoricanus* on the other hand, an undoubted off-shoot of *alveus* that has developed the double-brooded habit, appears to have no more difficulty in retaining that habit as completely in its most northerly habitats as in Algeria or Corsica. This looks as if the development of the habit was not dependent on climatic conditions, but on some inherent constitutional peculiarity developed, in all probability, in regions inhabited by both species. It is only reasonable to suppose, then, that if *numida* could have extended its habitat to the northern shores of the Mediterranean it would have retained the double-brooded habit. Further, we have no reason to suppose that in the days when *alveus* inhabited northern Africa it was other than single-brooded. This being so, it is probable that *numida* has altered constitutionally to such an extent, that it can no longer possess really close affinities to the parent form. I have therefore classed it as a distinct species. Before leaving the subject of *numida*, it may be interesting to point out that, as is shown on Plate XXXVIII, aberrations

of *alveus* showing almost the typical facies of *numida*, and every possible transition to that form, are common; but no aberration of *numida* approaching the alvean type is known. This is a very suggestive fact, even allowing for the fact that we are not half as familiar with the insect as with *alveus*; but it is, of course, what one would expect, granting that *numida* is a distinct species which has been evolved from *alveus*.

There remain three other forms of doubtful rank in the genus *Hesperia*, the subspecies *sifanicus* and *iliensis*, both forms of *alveus*, and *persica*, a race of *armoricanus*. The case of *sifanicus* is similar to that of *accreta*, almost everything that could be said of the latter would apply to the former. The two differ only in that the genitalia of *sifanicus* are even closer to *alveus*, and the superficial facies a little more distinct. The possibilities of *sifanicus* being a true specific unit do not seem great. Still, we know much less of the insect and its distribution than we do of *accreta*, and even the distribution of typical *alveus* in eastern regions is but little known. More information on these points might greatly alter our opinions. So I retain *sifanicus* as a subspecies for the present, which seems to be all that the available data justify one in doing. The case of *persica* is more unusual. Here we have an insect with a slight, and apparently constant, distinctive character which distinguishes it anatomically from *armoricanus*, from which on the whole it is superficially not distinguishable. The whole question, then, is, whether the distinctive feature of the genitalia is sufficiently pronounced to separate these otherwise similar forms into two species, or not. Personally, I have no hesitation in saying it is not. The only difference between the two armatures lies in the formation of the apex of the cuiller. This minute difference might be accepted as sufficient conformation of specific distinction, if backed up by some difference such as different flight periods, or even if the insects were superficially very different; but otherwise not. In the several cases we have in the genus *Hesperia* of distinct species bearing similar facies, the genitalia are invariably absolutely different, so much so that there can be no question of there being any connection between them. In the case of *persica* the relationship to *armoricanus* is unmistakable, which fact in itself is, when taken in connection with the superficial similarity, almost conclusive proof that the two are one species. I therefore retain *persica* as a race of *armoricanus*. Both are double-brooded, and occur together in some localities, which shows that the former has not yet attained a subspecific standing.

The case of *iliensis* is, and must remain for the present, doubtful. Only a few specimens are known, and these differ superficially from *alveus* to a certain degree, but the genitalia cannot be said to do so. On the whole the ♂ armature is very much as in *accreta*, the only difference being the presence of spines on the apex of the cuiller in *iliensis*, as is usual in *alveus*. We know nothing of the distribution of this form, but typical *alveus* is known to occur over a wide area in central Asia. It seems wisest therefore to retain it as a subspecies of *alveus* until further data are procurable.

Leaving the genus *Hesperia*, we find some very complex questions in the genera *Powellia* and *Tuttia*. In the former, the difficulty lies with four species of the *sertorius* group: *sertorius*, *ali*, *therapne* and *orbifer*. The first and the last have long been accepted as two good species, and more recently Reverdin has asserted that *ali* and *therapne* are distinct too. First, it must be said that there is only one distinctive character in which the genitalia of all four differ, and that one is not entirely free from variation. Between *sertorius* and *orbifer* there exists a second. The main difference lies in the formation of the lateral

apophyses of the 10th sternite. It is not necessary to describe the differences here, they are clearly shown on Plate LI. The formation in *sertorius* is apt to vary, sometimes approaching *therapne,* sometimes *orbifer*; but the typical form of each species is undoubtedly the one figured. The second difference between *sertorius* and *orbifer* is to be seen in the form of the rudiments of the subharpal plate, unfortunately not entirely constant either. All the same, it is often very useful, the variation keeping within certain limits. One is left, however, so far as *ali* and *therapne* are concerned, with little to support the idea of their specific standing, beyond the forms of the lateral apophyses. *Ali* shows a certain amount of difference of design which *therapne* does not, the difference between it and *sertorius* being a matter of size and colour. In Spain, where climatic conditions form an approach to those prevailing in north Africa, we find a small race of *sertorius*, in size and in the coloration of the underside of the hind-wing approaching *ali.* The only item, apart from the slight difference in the genitalia, which can be taken as substantiating the specific claims of *ali* and *therapne*, is that in their restricted habitats transitional specimens between them and *sertorius* do not seem to occur. The value of this fact is somewhat discounted by the enforced isolation in those habitats, it being obvious that, no matter how widely the insects may be dispersed, they can never come under the influence of conditions approaching those of Central Europe. However, the local conditions are not so greatly different from those prevailing in southern Spain, and southern Italy; and the entire constancy of the types in north Africa and in Corsica and Sardinia is noteworthy, and shows that there is no tendency to produce *sertorius*-like forms under the stimulus of variation-compelling forces. This is not because such forces are wanting, for *ali* produces a seasonal form very similar to *therapne.* In its lateral apophyses *sertorius* occasionally approaches *therapne*, but I have never seen a specimen of either it or *ali* which showed a corresponding approach to *sertorius*. This points to their being distinct from the latter now, and having originated from it. The combination of these facts and the slight structural characteristic lead me to assume that *sertorius* is distinct from *ali* and *therapne*, but how the latter two species stand to each other is perhaps more doubtful. The lateral apophyses are closer to each other than to those of *sertorius*, and in both there is practically nothing to be seen of the edge of the subharpal plate. There remains, however, the striking fact, that on the underside *ali* differs in design from *therapne*, which difference holds good even in the second brood specimens, which are very similar to *therapne* on the upperside. *Ali* too, in spite of its more southerly habitat, is a larger insect (the tendency in *sertorius* is to decrease in size as it goes south), and though the form of the second brood suggests relationship with *therapne*, the constant shape of the markings of the underside in both broods suggests that the coloration of the upperside in the second is only due to some seasonal cause. This could not be the case with *therapne*, so it seems possible that the two may be less closely allied than the slight structural difference would lead one to suppose.

The standing of *orbifer* and *sertorius* does not leave much room for doubt. The superficial features of the two are clearly different, both in design as well as colour, and the habitats of both are separated but the separation is not enforced, and finally, the genitalia offer two distinctive characters. The variation to be seen in the genitalia of *sertorius* is the only point which could raise doubts on the question. This variation, however, while producing occasional specimens with the lateral apophyses practically as in *orbifer*, does not seem sufficient ground for uniting the two as one species. I have never seen a

specimen in which the lateral apophyses and the existing fragment of the subharpal plate were both abnormal, and I have always been able to identify any specimen by one or other character. The four species we have been considering are very closely connected, and therefore analogous variation is only to be expected, yet this does not alter the fact that each species (for such I shall continue to call them) has developed a distinctive formation, though retaining the inherent tendency to certain forms of variation.

Turning to the genus *Tuttia*, we find what is perhaps the most complex case of all. Since the publication of Reverdin's "Revision of the genus *Hesperia*," we have regarded *nomas* and *tessellum* as two distinct species. There is a distinct difference in the genitalia between what appear to be the most ordinary forms of *tessellum* and *nomas*. The difference lies in the height to which the cuiller extends upwards, and the formation of the teeth which rise from its dorsal extremity. A certain amount of variation was known to exist in *tessellum*, but it did not seem important, and the formation peculiar to *nomas* was, so far as was known, constant. This, in connection with the striking difference in the underside of both, seemed quite to warrant their specific separation. In 1922, however, Reverdin discovered a number of specimens approximating somewhat in size and markings to *F. cribrellum*. The genitalia showed that these specimens belonged to *tessellum*, although there were some minor points not quite similar. Just about the same time I came on some very similar specimens. These, however, on dissection proved to be indistinguishable from *nomas*. In consequence of this, we both mounted the genitalia of as many specimens as we could obtain, which gave the following results.

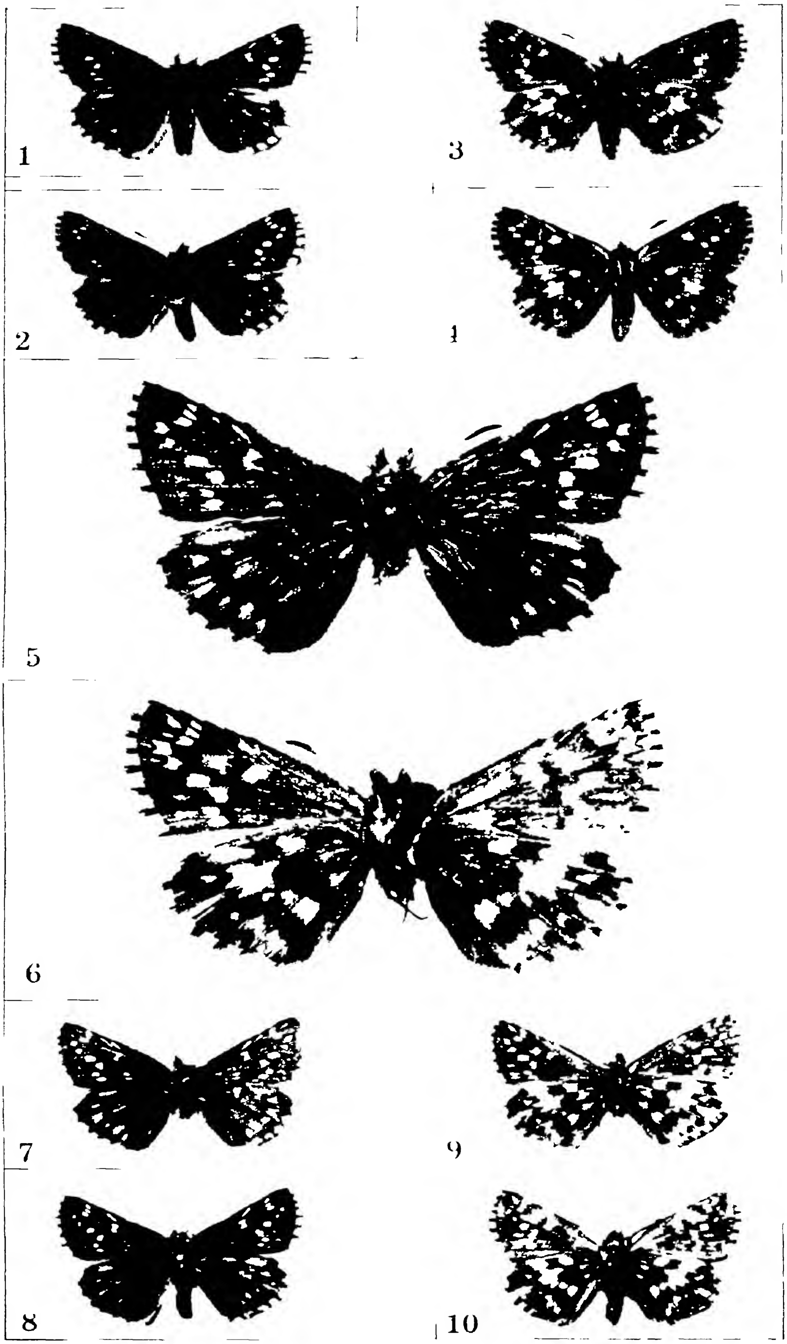
1. *Nomas*, anatomically, was the least variable, but, even so, it cannot be said to be really constant, some examples being very similar to *tessellum*.

2. The smaller, heavily marked specimens of *tessellum* were the most variable, both structurally and superficially, and passed insensibly both in size and markings into the typical, large and sparsely marked form. When a considerable number of specimens were together it became impossible to enumerate any characters which could be maintained as even sufficient to define two recognisable races, in spite of the fact that many of the extreme specimens of this small form might easily be mistaken for *cribrellum* by anyone not really familiar with the two species. Anatomically, they were equally variable, some having a similar armature to *tessellum*, others to *nomas*, and yet others showing various intermediate stages.

3. A few specimens of typical *tessellum* showed genitalia forming a marked transition to *nomas*.

From this, it is obvious that we cannot maintain *nomas* as distinct from *tessellum*; it further gives one a very interesting combination of facts.

Nomas is a subspecies. So far as I can ascertain (in spite of Mabille's record in Seitz's *Macrolepidoptera*) it does not occur in Europe. Every specimen I have seen in museums or private collections has come from Asia Minor, and typical *tessellum* does not extend at all so far south. Further to the north, wherever we find *tessellum*, it shows considerable tendency to anatomical variation, developing to a racial extent the same variation which accompained the evolution of *nomas*, but in these regions in connection with a very different superficial appearance. As was previously stated, many of these *tessellum* are very similar to *cribrellum*, and all of them are a development of typical *tessellum* towards the latter species. This strongly points to the conclusion that mimicry is responsible for the development of these facies,



J. Bale, S. & D. Ltd. [illegible]

Hesperia sibirica and *H. chapmani*

1 and 3. *H. sibirica* ♂ (Type). Natural size.
2 and 4. ,, ♀ ,, ,, ,,
5. *H. chapmani*, Upperside × 2. Vitim, N. of lake Baikal.
6. ,, , Underside ,,
7 and 9. *H. chapmani* ♂ (Type). Natural size.
8 and 10. ,, ♀ ,, ,,

otherwise why should not the same external appearance have accompanied the internal variation, as happened in the case of *nomas* in, at any rate, some proportion of the specimens? *Tessellum* and *cribrellum* inhabit the same ground in the localities where these specimens come from, which further supports the possibility of mimicry. As the difference of appearance between some of these small *tessellum* and *cribrellum* is much less than the difference between the former and typical *tessellum,* very little further change might produce a race of *tessellum* indistinguishable from *cribrellum*, the two still anatomically absolutely unlike, and members of different genera. This is a very perfect example of the process which must have led to the development of such species as *malvae*, *malvoides* and *pontica*.

Before concluding, it may be well to point out, that in spite of a certain similarity between this case of *tessellum* and *nomas*, and that of *alveus* and its eastern allies (*reverdini*, etc.), the two are really very different. Our conclusions, that *reverdini* and *speyeri* are species, and that *nomas* is only a subspecies, are not, as might be thought, contradictory. In *tessellum* the armature of *nomas* is developed exactly and entirely as in *nomas*, with considerable frequency, while in *alveus* the peculiar characteristics of *reverdini* and *speyeri* are only partially produced, never perfectly developed, and only occur very rarely. In *alveus* we get the beginning of a formation occasionally, in *tessellum* we get both the beginning and the completed object not uncommonly. The amount of structural variation existing in *tessellum* is truly remarkable; the various formations are fully described and illustrated in our systematic part. Finally, in *reverdini*, etc., the structural characteristics are constant, or rather they do not vary in the direction of *alveus*, and with *nomas* we know this is not the case; certain specimens do approach *tessellum*.

VIII. Hitherto undescribed Species of Palaearctic Hesperids (Non-European).

1. **Hesperia chapmani**, sp. n. (Pl. XI, figs. 5–10.)

This species is very close to *H. sibirica*, and though abundantly distinct anatomically, I am not able to separate the two by their superficial facies. On Plate XI the type specimens of *sibirica* (♂ and ♀) are figured, and also the types of *chapmani* of both sexes. So far only five specimens of the latter are known, a ♂ and ♀ (figs. 7–10) in my own collection (types), 2 ♂s in the Reverdin collection, and 1 ♂ from the Chapman collection, now in the British Museum collection (fig. 5). Of these the ♀ must remain a doubtful quantity, for our only ground for calling it *chapmani* is that it came from the same locality as the ♂; we do not know if *sibirica* occurs in that locality also; that it might do so is quite possible, for it seems to be widely distributed in Central Asia. In the 4 ♂ specimens of *chapmani* one can note certain characteristics which might distinguish them from *sibirica,* but as the latter seems to vary in those particular characters they are no help until we are in possession of a good series of both. In view of the meagre material at present at our disposal, I am not without hope that, if ever a considerable number of both species are obtained, we shall be able to distinguish them by their superficial characteristics. This will not seem undue optimism on my part, if we reflect that, had we only four specimens of *H. foulquieri* and two dozen *H. alveus*, we should certainly not be able to grasp the combination of characters which enable us to distinguish those two species superficially. To turn to the true distinction

between *chapmani* and *sibirica*. The ♂ armature of both will be seen on Plate IV, fig. 1 *sibirica*, fig. 2 *chapmani*. A glance will show the completely different form of the cuiller. In *chapmani* the terminal elevation of the cuiller is pointed, the distal edge sloping immediately down from the point in an unbroken curve to the proximal end of the cuiller. The formation in *sibirica* shows a rounded summit, of practically the greatest width which the cuiller develops; while the distal aspect, instead of being a continuous curve, is flattened for a length almost equal to the free part of the proximal edge. The breadth of the clasp varies a little in *sibirica*. At its widest point, immediately above the proximal end of the cuiller, it is never so developed that its dorsal edge is level with the summit of the latter, and it is often distinctly lower. In *chapmani* the dorsal edge rises above the summit of the cuiller. Finally, in *chapmani* the proximal end of the aedoeagus is both longer and more slender than in *sibirica*, and the ventral line of the antistyle is a perfect curve in the former, and angled in the latter. There is some slight variation in the form of the extreme tip of the cuiller in *chapmani*, two of the specimens not having it quite so sharply pointed as in the one figured; but this slight variation does not in any way alter the characteristic appearance of the whole structure.

The distribution of these two species is almost unknown. *Sibirica*, as its name suggests, is an inhabitant of southern Siberia, and some specimens are known from the Altai Mountains; but beyond these vague indications we have no information on the subject. Of the known specimens of *chapmani*, the two type specimens come from Munko Sardyk in the Sajan Mountains; one ♂ from Vitim north of Lake Baikal, and one ♂ from southern Siberia. This shows that both species occur in the same districts, but otherwise leaves one in complete ignorance. We must rest content for the present only to record the fact that these two species exist, and hope that the future will bring us fresh light on the subject.

2. **Sloperia ioan**, sp. n. (Pl. XII, figs. 3 and 4.)

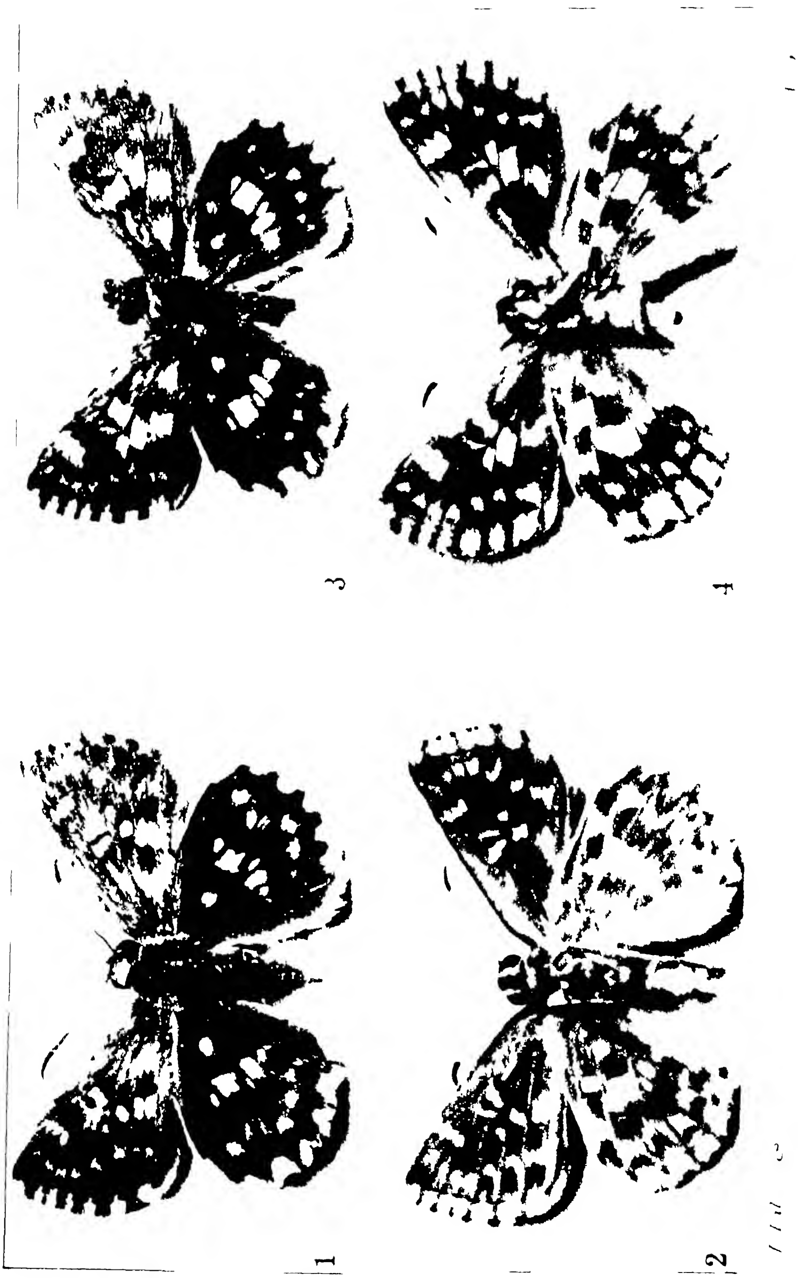
Superficially and structurally this species is somewhat closely related to *S. poggei* and *S. lutulentus*; it occurs in Syria, and also in the Taurus Mountains, with the former. (Type ♂ and ♀ in Warren coll.)

The species may be described as follows: —

S. ioan: In size and shape absolutely similar to *S. poggei*; markings also similar. Size 34—36 mm.

Upperside: Ground-colour deep brown; fore-wings heavily scaled with grey; spots of median row very large and square, 5th and 6th wanting; outer row complete, but composed of very small spots partially covered by grey scaling; inner row wanting, except for the discoidal lunule which is very pronounced. ♂ with a rudimentary costal fold. Hind-wings, with 2nd basal spot strongly marked, 3rd faintly visible, 1st wanting; median band composed of very broad spots of regular outline, stopping at 7th nervure; marginal row composed of very small somewhat rounded spots, also not extending beyond 7th nervure; inner marginal half of wing heavily scaled with grey.

Underside: Markings of fore-wings as on upperside, showing strongly on dark background. Hind-wings, with ground-colour pale, dull yellow; nervures only partially visible; 2nd and 3rd basal spots large and square, the latter advanced up to the inner edge of the median band, 1st wanting; median band broad, with last spot (that between 7th and 8th nervures) indistinct and set back towards the outer margin of the wing; spots of marginal row small, indistinct and well separated.



On Plate XII two ♂s of *S. ioan* are illustrated, with *S. poggei* for comparison, all exactly twice the natural size. Although very similar to *poggei*, *ioan* can easily be distinguished from that species by the large, square white spots of the median row on the fore-wings, and also the heavy discoidal lunule; the corresponding markings in *poggei* being much smaller and more suffused, on both upper and undersides of the wings; while on the hind-wings in *ioan* the spots of the marginal row are small and well separated, on both upper and undersides, and the same spots of the hind-wings in *poggei* are twice the size, practically united (being only separated by the nervures) and more or less arrow-headed in formation.

From *S. proto*, which it also resembles to a certain extent, *ioan* can be distinguished by the pointed and slightly hooked tips of its antennae, and the formation of the median band on the underside of the hind-wings, and in the ♂ by the fact that the costal fold is only partially developed. In *proto* the last spot of the median band is as well developed as the others, and is broadly united to them, and the band is well separated from the basal spots; the costal fold of the ♂ is, of course, very fully developed.

From *lutulentus*, *ioan* can be distinguished, like *poggei*, by the thick dusting of grey super-scaling on the upperside. This scaling is wanting in *lutulentus*, though the fact does not seem to be recognised, judging by the number of specimens of *poggei* one sees in collections labelled *lutulentus*. Mabille in his description of the latter says, " the fore-wing is not dusted with ashy grey, but is as black as the hind-wing." Further, he notes that the habitat of *lutulentus* is Turkestan, which should have prevented specimens from Syria being confused with it.

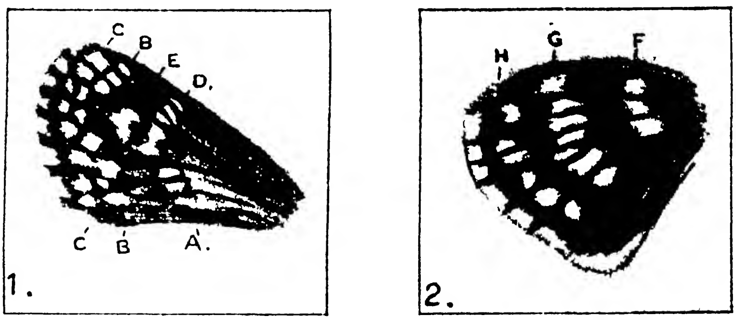
Anatomically, *poggei* and *lutulentus* are the only species which make any real approach to *ioan*, and even from these two it stands very distinctly apart. The genitalia of *ioan* (Pl. VIII, figs. 2 and 3) differ from those of *poggei* and *lutulentus* (Pl. VII, figs. 4 and 5) in the broad cuiller with its blunt dorsal termination, strikingly different from the narrow pointed formation we see in the two latter species; and the harpe in *ioan* equally broad at its termination, and equally different when compared with the harpal formation of *poggei* and *lutulentus*; and, finally, the lateral apophyses of the 10th sternite in *ioan* are short and curved, distinctly suggestive of the claws of a bird of prey, showing that there is less connection between *ioan* on the one hand, and *poggei* and *lutulentus* on the other, than between the two latter species.

The distribution of *ioan* is uncertain. It is common in Asia Minor, whence, with one exception, come all the known specimens. There is a good series in the British Museum collection from Syria, the Caucasus and Armenia; of the four specimens in my own collection, 2 ♂s come from the Taurus Mountains, and 1 ♂ and 1 ♀ from Syria; there is a single ♂ in the Bethune-Baker collection from the Taurus Mountains labelled July 1904; and 2 ♂s in the Reverdin collection, one from Syria and one from Tian-Shan. The latter is the exception previously mentioned, and one cannot help wondering if it was incorrectly labelled by accident. Reverdin, however, received it from Bartel, who was so much more careful than the average dealer in the matter of data labels, that I am inclined to think the label correct, and to assume that *ioan* is not restricted to Asia Minor as *poggei* is. Only one specimen, that in the Bethune-Baker collection, bears a date, so we cannot form any idea as to whether *ioan* is double or single-brooded. (If any of the descriptive terms applied to the wing-markings in the above descriptions of *S. ioan* are unfamiliar, they will be found fully explained in the following part.)

IX. Explanation of Hesperid Wing-markings, and descriptive Terms employed in the Monograph.

In dealing with species, many of which have very similar facies, the usefulness of a systematic work depends largely on the descriptions being easily understood; so it is necessary to give a brief description of the principal features in the wing-markings of the Hesperids. The markings of the fore-wings are the most complicated, and nearly always incomplete; with the hind-wings there is not much trouble. The diagrams do not represent any special species, but are drawn to illustrate the complete Hesperid markings, and show characters taken from a number of different species. As far as possible, I have used the terms which have been in common use.

Fore-wings. (Compare Text-fig. 1 (1).) The fore-wing markings consist of five main features: an inner row of white spots, known as the discoidal series; a median row; an outer row; a series of sub-costal spots; and the discal spot. To take these features in order:—



Text-fig. 1.—Diagram of wing-markings in Hesperiidi. (1) Forewing, (2) Hindwing.

A. *The discoidal series.* This is the innermost row nearest the base of the wing, and consists of four spots, the 1st situated on the inner margin, the 4th in the discoidal cell, known as the discoidal lunule.

B. *The median row.* This row consists of nine spots, the 1st situated on the inner margin, the 9th almost touching the costa. This row is always very irregular, and especially so in the genus *Hesperia*. The 1st, 2nd and 3rd spots are often more or less immediately beneath the discoidal lunule, which gives the mistaken impression that the discoidal lunule is a unit of the median row, especially as the 1st, 2nd and 3rd spots of the inner row are often entirely wanting. In some species one sees, as in the diagram, how clearly separated the inner and median rows really are. The discoidal lunule and the median row together form Lang's " Q-mark "; but it is much better, for descriptive purposes, to keep the two rows quite distinct.

C. *The outer row.* This row, when present, consists of a series of eight distinct white spots, between the median row and the outer margin of the wing. The 1st spot is only very rarely present, frequently only indications of the spots are visible, and many species are entirely without them.

D. *The subcostal spots.* These spots, three in number, are usually small wedge-shaped streaks immediately above the discoidal lunule. Their position and size are variable, they are often wanting, but never more than three. They are of value in the identification of many species.

E. *The discal spot.* This spot is situated between the discoidal lunule and the median row. It is often wanting, and never really sharply defined, though occasionally well developed.

There is occasionally, in some of the species of the genera *Sloperia* and *Powellia*, a white spot situated at the base of the discoidal cell. This I shall call the inner discal spot. It is only found in a very few Palaearctic species.

HIND-WINGS. (Compare Text-fig. 1 (2).) The markings of the hind-wings are of a quite simple character, consisting of three main features.

F. *The basal spots.* Spots situated in close proximity to the base of the wing, three in number, very variable in size and formation, referred to as the 1st, 2nd and 3rd, the 1st being the one next the inner margin of the wing.

G. *The median band.* A series of spots running from the costa to the middle of the inner margin, often more or less united and having the appearance of forming a continuous band.

H. *The marginal row.* A series of disconnected spots situated close to, and often touching, the outer margin of the wing, the latter position being usual on the underside, but rare on the upperside of the wing. This row of spots has often been called the " outer row," but it seems better, and to leave less chance of mistakes occurring, that no two series of markings should be known by the same name, even though they refer to different wings. All the terms, however, refer equally to the upper or undersides, as the markings are essentially the same, though sometimes less strongly developed on one side than the other.

Here and there throughout the following monograph, I have referred to characters as being definable or non-definable. The former are, naturally, those which can be precisely described; the latter are those which are distinct in an extreme form, but which vary so extensively as to pass imperceptibly into a second form, in a manner which renders it quite impossible to fix any definite limit to either character or to say where one ends and the other begins. Such non-definable characters are by no means rare in many species of HESPERIINAE.

All measurements of the size of the insects represent the measurement from the centre of the thorax to the apex of the fore-wing, $\times$ 2.

All the photographs of the genitalia are taken from mounts prepared in the same way, whether they are Reverdin's, Chapman's or my own, *i.e.* the organs are mounted in profile, and the left clasp removed entirely, so that the right clasp is seen from the inside. Whatever may be the advantage of other methods of mounting in other families, there can be no two opinions as to the far greater value of this method in the HESPERIINAE, or for the matter of that, in any group where it is desirable to study these organs unmounted. The exact natural position is seen in the photographs, for it is the natural position when the insect is alive, and by no means whatsoever can anyone get the same natural view of the various parts in correct relationship to one another by splitting the object and mounting it on its back. The distorted mass of all the dorsal parts, which results from this flattening out, entirely destroys the natural shape of those parts, and consequently renders the photograph completely useless for comparison with the undamaged object. That, in the profile mount, the tegmen is double, is of no importance, for this structure is invariably composed of absolutely featureless chitin, and the 10th segment is plainly to be seen in its proper position and formation, which is of the greatest importance.

In all the following descriptions of the genitalia, comparison is only drawn between the species of the same group or genus, as the case may be; for the

characteristics of each group or genus, which are given to start with, render confusion between the units of these divisions impossible.

The superficial characters given for the various genera and groups will be more evident, and therefore more trustworthy, in a series, than for single examples, on account of the great extent of individual variation. They are based on the most typical forms, which were selected as such, after the examination of as large a number of specimens as possible, in private and public collections.

The superficial characters mentioned may appear in some cases to be of a very insignificant nature, but it must be remembered that the facies of the Hesperids are very unreliable as characters on which to form any groupment of species, and that, in many cases, groups which seem very similar according to such characters, will be found to include species of quite other groups, and to exclude others which are closely allied. This makes the selection of superficial characters for genera, etc., a matter of considerable difficulty, and if the collector finds the characters offered less definite than he could wish, he can console himself with the knowledge that they point out to him, to the best of our present knowledge, the true affinities of the species he is studying, and do not merely represent groups of similar-looking individuals but of quite fictitious value.

X. Monograph of the Tribe Hesperiidi. (European Species.)

Genus **HESPERIA**, Fabricius.

Structural Characteristics.—Harpe, strongly developed; short; not extending to distal extremity of clasp; terminating on or before proximal edge of cuiller; bearing style and antistyle: 10th sternite fully or partially developed, complete or incomplete ventrally.

Superficial Characteristics.—Black species with white spots on the upperside: fore-wings with median row of spots complete, but sharply angled; 6th spot moved outwards, nearer to outer margin of wing than any other spot of the row.

Subgenus: TELEOMORPHA, Warren.

Structural Characteristics.—Tenth abdominal segment in ♂ entire, forming complete circle.

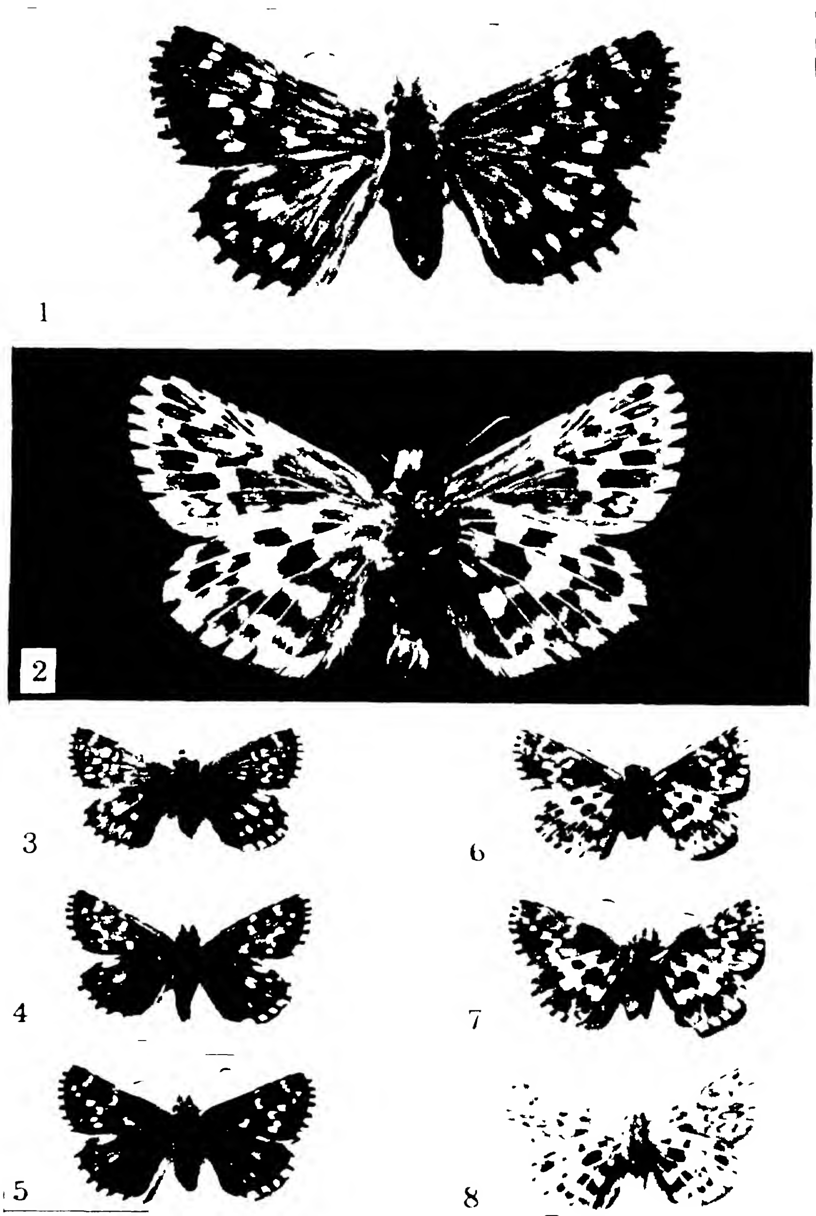
I. **CENTAUREAE Group.**

Structural Characteristics.—Tenth sternite in ♂ simple and entire; whole length of dorsal edge of harpe curved; style long and folded over close to harpe.

Characteristic Facies.—Upperside fore-wing discal spot wanting, or if present, very indistinct and narrow, rarely half as broad as the discoidal lunule. Central spot of median band underside hind-wing projecting sharply towards base of wing.

Hesperia centaureae, Rambur. (Pl. XIII.)

Identification.—*Genitalia.* (Pl. XV, fig. 1.) In *centaureae*, the most noticeable feature is the great width of the clasp, which is, at approximately the centre, almost equal to half the length. This width is the result of a strong expansion of



J. Bale, S. & D. Ltd. ... London ... Warren

Hesperia centaureae

1. Upperside, 2 ×. 2. Underside.

Natural size

3. Sæterstoen. 6. Sæterstoen.

4. Lapland. 7.

5. Sæterstoen. 8. ab. *fasciata*, Altai.

the central portions between the harpe and the ventral plate. The style, which is of the flat ribbon-like pattern common to the group, is shorter than in the other species; the cuiller expands slightly towards its summit, where it is bluntly rounded off, not assuming any specialised terminal formation, and still considerably below the level of the dorsal ridge of the harpe. Between the proximal edge of the cuiller and the distal edge of the harpe there is a considerable space, roughly triangular, as the cuiller is set well back from the harpe and its proximal edge does not follow the same curve as the distal edge of the latter. This triangular space is only present in one other European species, i.e. *freija*. The blunt evenly-rounded termination of the cuiller, the broad style, and the sharp up-turned point rising from the anti-style, are all unmistakable characters by which *centaureae* can be distinguished from the latter species. The sharp termination to the antistyle, in particular, is entirely peculiar to *centaureae*.

General features.—Size, 30–34 mm. *Upperside:*—Fore-wings: discoidal series incomplete, 3rd spot wanting; median row complete, 3rd and 4th spots almost touching, 7th, 8th, and 9th usually the same size; outer row wanting; discal spot just discernible; subcostal spots present, all three usually situated immediately above the discoidal lunule. Hind-wings: basal spots wanting; median band incomplete, central and costal spots usually present; marginal row present. *Underside:*—Fore-wings: discoidal series incomplete, discoidal lunule alone present; median row complete; discal spot faintly visible; no other defined markings. Hind-wings: basal spots present, strongly developed, of more or less square formation; median band complete, central spot projecting sharply towards base of wing; marginal row present; nervures strongly outlined in white.

Comparison with the other Species of the Group.—*Centaureae* bears more resemblance to *freija* than to any other species of the group, but can be distinguished by the white tooth-like projection on the underside of the hind-wing, which extends from the margin along both sides of nervure 5, or such part of nervure 5 as is present. Also, by the fact that the marginal row of spots is never so developed as to form a complete row of arch-shaped spots enclosing lunules of the ground-colour, as is the case in *freija*. The ground-colour is of varying shades of dark brown, often tinged with green or yellow. The greater breadth, in proportion to the length of the wings, in *centaureae*, is a readily grasped feature of the insect, but while it may be relied on, to a very great extent, to identify a specimen as *centaureae*, the converse is quite unreliable; specimens of *centaureae* with quite as narrow wings as *freija* being by no means rare.

The only other species of the group at all resembling *centaureae*, is *andromedae*; and, as it happens, the two often occur on the same ground. *Centaureae* is, however, easily distinguished by the absence of the 3rd spot of the inner row on the upperside, and on the underside by the very strongly-marked white nervures on the hind-wing, and the three square basal spots of the same, spot 2 being always as pronounced as 1, the latter never being any longer than 2 or 3. If the characteristic form of the basal spots and the coloration of the nervures are carefully noted, there should never be any difficulty in distinguishing these two species.

It is not necessary to consider any of the remaining species of the genus, as none outside the group are at all similar to *centaureae*.

Sexual Dimorphism.—The sexual dimorphism in *centaureae* is very slight. The ♂ has a costal fold on the fore-wings, beyond which it is difficult to say if there is any constant difference between the sexes. A suffusion of lighter-coloured scales over the upperside, a character frequently seen in the ♀ Hesperids, seems to be equally pronounced in either sex, both varying con-

siderably in this respect. The apex of the fore-wing in the ♀ is very slightly more rounded than in the ♂.

Variation.—The variation of *centaureae* seems to be decidedly limited. Compared, however, with the other species of its group, the material we have to judge from is so very scanty that it is quite impossible to hope to form any really accurate estimate of its variation. On the upperside the subcostal spots may be reduced to two, or more rarely one, or their position may be altered; for they occasionally are extended towards the apex of the wing, one after the other, in the manner of those spots in *H. sidae*, instead of being almost one over the other. It is an unusual feature to find this variability of position, for in most species the position of these spots is markedly constant. Another character of the upperside which varies, is the first two spots of the inner row. These not infrequently are united, and appear as a single spot, while much more rarely the second is wanting. The amount of white on the hind-wings also varies extensively, but not in at all a striking manner. On the underside, the spots which are situated between the margin and the median band of the hind-wing are the most variable feature. These spots really are an extension of the white markings of the margin, though when more developed they appear to be an additional row between the median band and the marginal row. The extreme form of this variation is interesting on account of its likeness to *freija*; it might be known as:

ab. **fasciata**, nov. (Pl. XIII, fig. 8.)

The specimen figured might at first sight be taken for *freija*, but it will be noted that the spots of the series are irregular in formation, and not like a row of miniature arches as in that species, and that also they unite with the margin over nervure 5, as a result of coalition with the extending tooth from the margin. The specimen illustrated came from the Altai, but it is a form which occurs in Lapland also. In addition to the marking of the hind-wing, this specimen shows a tendency to an increase of white all over.

The median band gives us some rather interesting forms. As will be seen from figs. 2, 6, 7 and 8 on Plate XIII, the typical type of median band is complete, extending from side to side of the wing, but the spots between nervures 2 and 4 are somewhat smaller than the rest. These two spots are occasionally lost, producing a further resemblance to *freija*.

There is a remarkable specimen in the British Museum collection, in which the central spot of the median band is united with the outer margin of the wing, making a long white streak half across the underside. This ab. is, of course, in spite of its very striking appearance, only the result of a slight development of the tooth-like spot from the margin; it may be called

ab. **striata**, nov.

On Plate XIII, fig. 6, a specimen is shown in which the projecting spot of the marginal series very nearly reaches the median band, and in addition it is so wide that a very little increase in width would fill up the whole space between nervures 4 and 6. Before leaving the subject of the median band, it is interesting to note that this, and the following, are the only species of the group of which I have seen no examples of the ab. *reducta*, Warr. This name was given to a form of aberration common to all the members of the subgenus, and to the *onopordi* group of the subgenus *Ateleomorpha* also, in which the inner edge of the central spot of the median band on the underside of the hind-wing has lost its characteristic irregular formation, and become quite or almost rectilinear. I

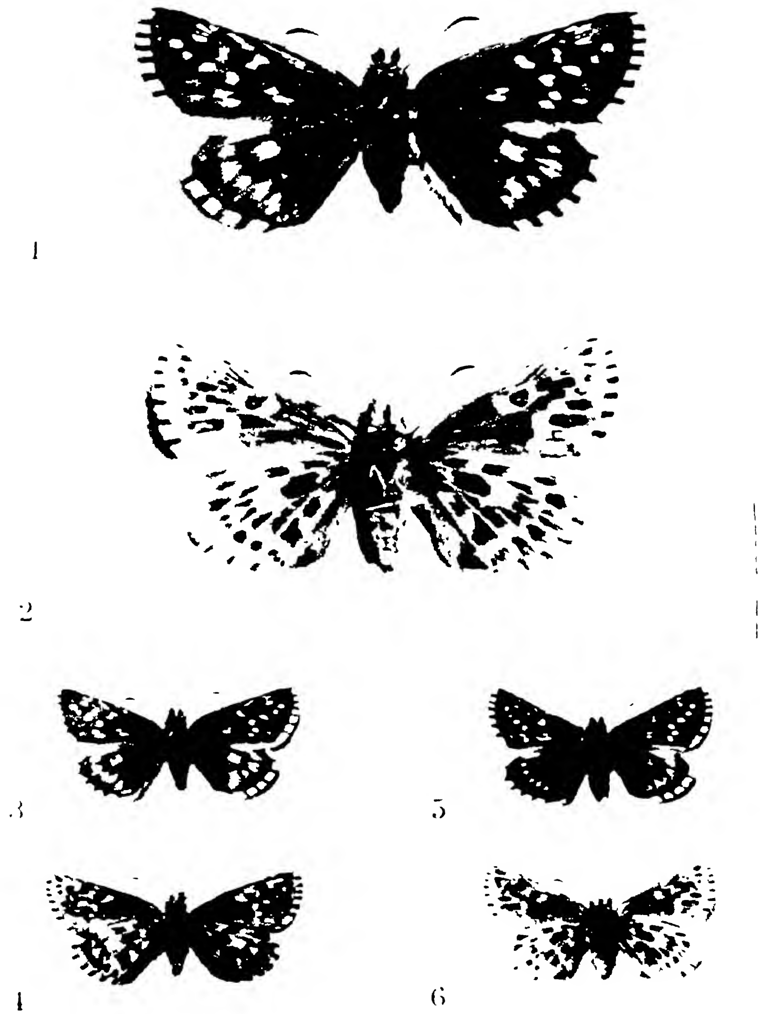


Photo ... Bacot — *Photo ... B. C. S. Warren.*

Hesperia freija.

1. Upperside, 2. ... 2. Underside, 2. ...

Natural size

3 and 4. Labrador (Type) 5 and 6. Lapland (Type)

have little doubt, however, that a greater number of specimens would show that *centaureae* is not immune from this line of variation, which has been such a fruitful source of confusion among the other species of the genus; especially as in some specimens of *centaureae* the projection from the central spot is somewhat less marked than usual.

Date of Emergence and Duration of Flight Period.—The available data on this subject are very limited. The species is single-brooded, emerging early in June, and continuing on the wing into July. The earliest record of emergence I have been able to find is June 4th, 1912, at Saeterstoen (Sheldon); the latest, July 6th, 1898, in the same locality (Chapman). As these records are in different years, they cannot be taken as a sound basis for forming an opinion as to the length of the flight period. Judging from my knowledge of the habits of the other species of the group, however, and the fact that the species never seems to have been found in large numbers at one time, I should say it is probable that the actual life of an individual would not exceed three weeks, but the total season during which it would be possible to take the insect on the wing might be more than double that time.

Distribution.—The distribution of *centaureae* in Europe is confined to the Arctic region, and a considerable part of Norway and Sweden. The total distribution of the species is very extended, ranging from North America to the Altai Mountains. In Norway and Sweden, it is a curious thing, but apparently *centaureae* extends considerably further south than does *andromedae*, which one would not at all have expected in view of the wide distribution of the latter in Central Europe. The most southerly point from which I have a record of the occurrence of *centaureae* is Odalen in Norway, at 60°14′ N. Lat., while Torne Träsk in Sweden at 68°30′ N. Lat. is the lowest latitude from which I have any reliable record of *andromedae*. It would, however, appear that the latter extends further north, or at any rate is of more universal occurrence in the extreme north, than *centaureae*, but one requires further confirmation on this point, as it might well be that *centaureae*, occurring, as it does, somewhat earlier than *andromedae*, is less in evidence at the season when the collector visits the highest latitudes and so gets passed over, especially as no collector ever makes any prolonged stay in those regions. The following are the only tested records available; they serve to show that the distribution of the species in Scandinavia must be very considerable.

European localities :—

Lapland.—**Lapland** (Chapman coll., Reverdin, British Museum coll.).
Sweden.—**Mattmar** (Sheldon).
Norway.—**Saeterstoen** (Chapman, Sheldon); Dovre Fjeld; Tydalin; Odalen (British Museum coll.).

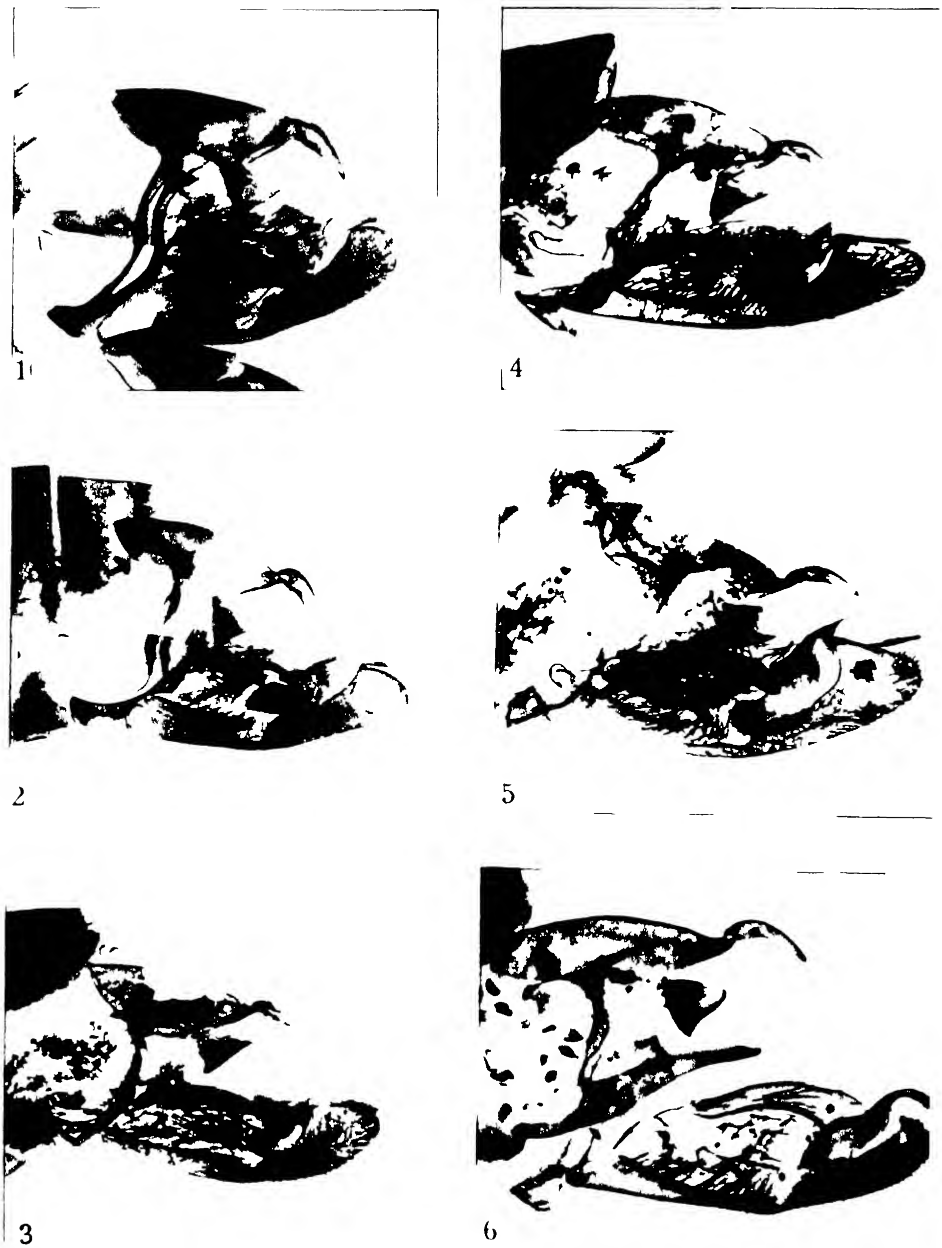
Hesperia freija, Warren. (Pl. XIV.)

Identification.—*Genitalia.* (Pl. XV, fig. 2.) The whole formation of the genitalia is on very similar lines to that of the last species. The points which so clearly distinguish *centaureae* from its allies are again in evidence here: the width of the clasp centrally, almost half the total length, the pronounced space between the proximal edge of the cuiller and the harpe, and the strongly convex, dorsal outline of the clasp. These characters enable the species to be distinguished from *andromedae*, *cacaliae* and *sidae*, by the most casual glance. Similar though the construction is, on the whole, to that in *centaureae*, a little closer examination will disclose

several marked differences. The cuiller expands considerably towards its termination, its ventral line being slightly concave just before the end. A sharp point rises from its summit, which has the effect of producing a very different terminal formation from what we see in *centaureae*. The style is narrow, and of equal width from the point where it is folded over, to its termination, in marked contradistinction to the broad, tapering structure in *centaureae*. The antistyle is bluntly rounded off on its dorsal apex; all of these features being easily observed on our plate. The difference to be noted in the form of the uncus in figs. 1 and 2, Pl. XV, is not so pronounced in reality, and is also subject to some variation in both species. The difference in the photographs is mainly caused by the two specimens having been mounted by different workers (fig. 1 Chapman, 2 Reverdin), and also, fig. 1 has been pressed slightly sideways out of the true profile, which has levelled the dorsal line unnaturally.

General features. Size, 28–32 mm. *Upperside*:—Fore-wings: discoidal series incomplete, 3rd spot wanting; median row complete, 3rd and 4th spots well separated, spot 8 smaller than 7 or 9; discal spot visible; outer row wanting; subcostal spots incomplete, usually only two present, 1st situated over discal spot, 2nd over (or nearly so) 9th spot of median row, but there is considerable variation in the position of these spots. Hind-wings: basal spots wanting; costal and central spots of median band more or less visible; marginal row fully present. *Underside*:—Fore-wings: 2nd and 3rd spots of discoidal series wanting; median row complete; discal spot fairly clearly visible; other markings variable. Hind-wings: basal spots present, 2nd smaller than the others; median band incomplete, spots between nervures 2 and 4 frequently wanting, central spot projecting sharply towards base of wing; marginal row complete, forming a white marginal band all along the outer margin of the wing, and also a complete row of more or less arch-shaped spots between the marginal row and the median band. Ground-colour varying shades of light brown, nervures more or less distinctly outlined in white.

Comparison with the other Species of the Group.—As in the case of the last species, *freija* does not resemble *andromedae*, *cacaliae* or *sidae* at all closely. The two latter need not be considered, being entirely different; but *andromedae*, occurring as it does with *freija*, must be mentioned, though to a collector who has had a certain amount of experience, there should be no trouble in identifying the two. In *freija* the characteristic formation of the marginal row on the underside of the hind-wings (very clearly seen in figs. 2 and 4 on Pl. XIV) forming, as one might say, an extra row, is in itself quite sufficient to distinguish the species from *andromedae*; and added to this there is the form of the 1st basal spot and the 1st spot of the median band, both quite normal in appearance in *freija*, never at all resembling the specialised formation in *andromedae*. With *centaureae*, however, there may often be more difficulty. The main points of difference have been noted already in connection with *centaureae*, so it will suffice to mention briefly the chief peculiarities of *freija* here. These are: on the upperside of the fore-wings, spots 3 and 4 of the median row well separated, the 3rd never being situated almost or quite over the 4th as in *centaureae*; and, on the underside of the hind-wings, (1) the row of arch-shaped spots between the marginal row and the median band, enclosing a complete series of lunules of the ground-colour; (2) the absence of any projecting spot from the marginal row, on the 5th nervure; (3) the reduction in size of the 2nd basal spot, and (4) the light brown shade of the ground-colour. There are several other points of difference which may be mentioned as usually distinguishing the two species, but they cannot be relied on for identification by themselves, as they are, unfortunately, liable to appear in *centaureae*. They are: (1) the absence of spots between nervures 2 and 4 in the median band



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Genus *Hesperia* male armatures

1 *H. centaureae* 2 *H. freija* 3 *H. andromedae* 4 *H.* [illegible] 5 *H. sidae* 6 *H. carthami*

on the underside; (2) the reduced size of spot 8 of the median row on the upperside of the fore-wings, strikingly smaller than 7 or 9, and (3) the narrow elongated form of the wings. These three characters occur occasionally in *centaureae,* and the first is not constant in *freija*; but on the whole they are typical of the latter.

As in the case of *centaureae,* it is unnecessary to consider any of the species outside the group, for none of them approach *freija,* or could possibly be confused with it.

SEXUAL DIMORPHISM.—The difference between the sexes appears to be very slight, but want of material leaves it uncertain that this is really so. From the series in the British Museum coll., the only points which can be noted are: ♂ with a costal fold, ♀ without; ♀ underside, all white markings more suffused than in ♂.

VARIATION.—The few specimens of the species at present known show but little variation; but, in view of its wide distribution, one expects this to be a misleading indication of the real facts of the case.

ab. **fasciata**, nov.

In this ab. the spots of the median band between nervures 2 and 4 on the underside are as well developed as any of the others, thus completing the band.

There are one or two specimens of this aberration in the British Museum coll.; they are decidedly suggestive of *centaureae,* but the characteristic features previously mentioned are unchanged.

A certain amount of variation is seen in the ground-colour of the underside of the hind-wings, which is occasionally somewhat darkened, though, on the whole, it seems to retain a lighter shade than *centaureae.* A few specimens exist in which the subcostal spots on the upperside are placed together over the discoidal lunule, as in *centaureae,* and one or two specimens in which spots 7, 8 and 9 of the median row are of equal size. Beyond this there is no variation to be noted in the few specimens we possess.

DATE OF EMERGENCE AND DURATION OF FLIGHT PERIOD.—It unfortunately has to be left to the future to establish any reliable information on these points. To only a few of the twenty-six known specimens are there any dates attached. These give one June and July and nothing more. The species is evidently entirely arctic and alpine, for as it extends southwards in America it ascends correspondingly. Thus we find it at 5000 ft. in Alberta, and at the great altitude of 13,000 ft. in Colorado. From these facts we may take it as certain that the species is single-brooded, and the duration of the flight period will probably not exceed six or seven weeks.*

DISTRIBUTION.—The distribution of the species is most remarkable, corresponding exactly to that of *Argynnis freija*; for this reason it was named after the latter species. So far as our present knowledge goes, the range of these two species is unique. They are found in Colorado, Alberta and Labrador

* Since this paragraph was written, I have received some specimens of *freija* from Mr. Ernest Bell of Flushing, New York, which were taken by Mr. Bell's collector in August 1923 and 1924, at Oslar, Ouray Peak, Colorado. As this locality is also at an altitude of 13,000 ft. and the specimens in rather poor condition, there is nothing in the August record to make one think that the species can be other than single-brooded. Mr. Bell also has a ♀ which was taken on the top of Pikes Peak, Colorado, on June 28th.

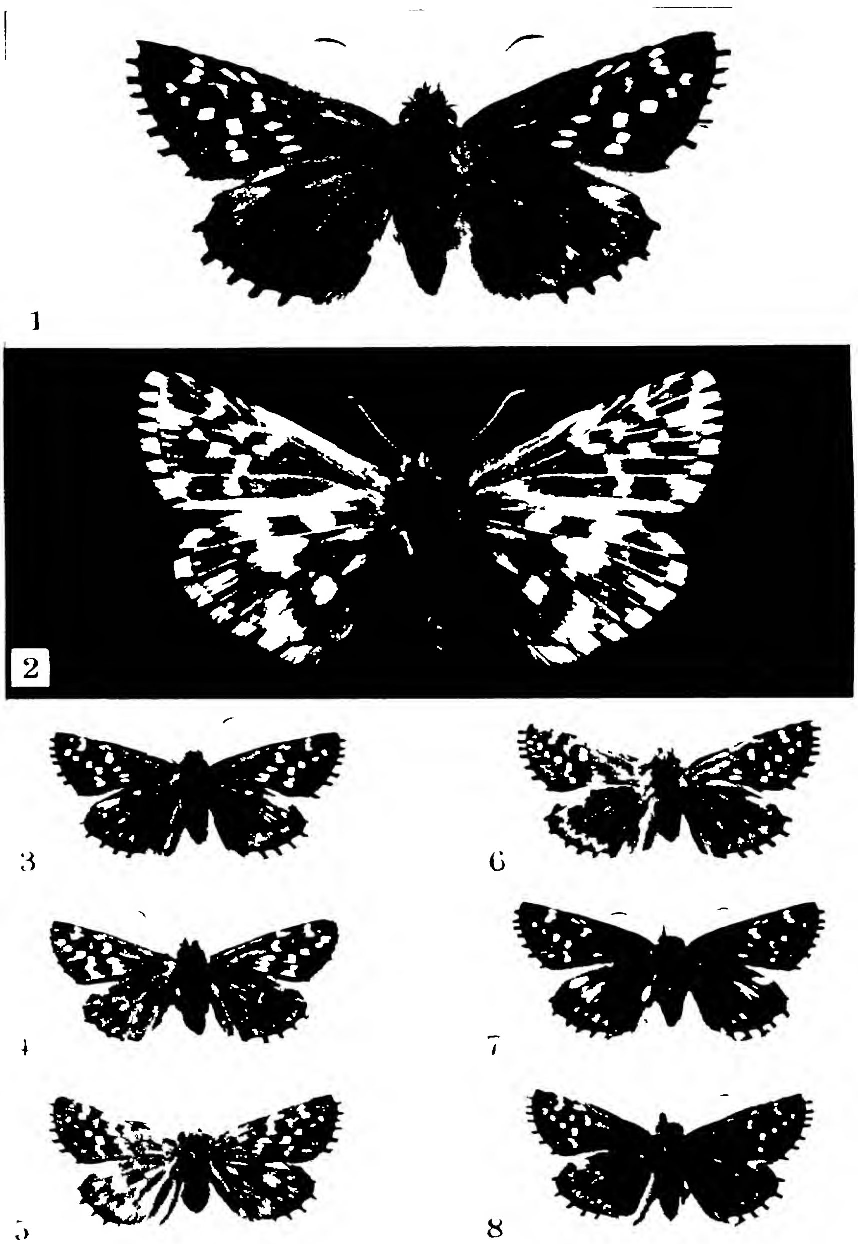
in America, and in Lapland in Europe. The Colorado specimens come from the Bullion Mountains at an altitude of 13,000 ft., the European ones all from Lapland. There are six specimens from Abisko in the Sheldon collection. These facts seem to suggest that *freija* is a more purely arctic species than *centaureae*. The two type specimens are figured on Plate XIV, figs. 3 and 4; the ♂ (Reverdin coll.) comes from Labrador, and 5 and 6, the ♀ (Warren coll.) from Lapland.

Hesperia andromedae, Wallengren. (Pls. XVI, and XVII.)

IDENTIFICATION.—*Genitalia*. (Pl. XV, fig. 3.) The dorsal line of the clasp is very much flattened, owing to the restricted development of the central area between the harpe and the ventral plate. This gives the whole clasp the long narrow appearance characteristic of this and the two following species. The width of the clasp centrally, at its widest point, is just one-third of the length. The ribbon-like style is long, extending to the end of the cuiller. The ventral line of the latter rises in an unbroken curve to the extreme limit of its elevation, its dorsal aspect being in consequence quite flat. Its proximal edge follows the terminal curve of the harpe closely, practically touching the latter throughout the whole of its course. The antistyle is very short and blunt, only projecting slightly from the stylifer. Ventral plate equal in width over its whole length. Subharpal plate of little density but expanding broadly, almost filling the entire area between the harpe and ventral plate. *Andromedae* may be distinguished from *cacaliae* by the features of the cuiller and ventral plate, just mentioned; especially by the horizontal, dorsal summit of the cuiller, where the dorsal and ventral lines of that process meet at a point which is at once both the extreme of its elevation and length. Also by the width of the ventral plate, which is almost as great where that process joins the cuiller, as at its proximal end.

General features.—Size, 32–36 mm. *Upperside*:—Fore-wings: discoidal series complete, the first three spots being somewhat elongated; median row complete; discal spot very faintly indicated; outer row wanting; subcostal spots present, situated more or less over the discoidal lunule. Hind-wings: markings very faint, central spots of the median band indicated more or less indistinctly; marginal row the same. *Underside*:—Fore-wings: first three spots of discoidal series wanting, discoidal lunule broad but variable in formation; median row distinct; discal spot very narrow but visible. Hind-wings: basal spots strong, 1st long and narrow tapering to a point towards the outer margin, 2nd smaller than 1st or 3rd, 3rd large and more or less square; median band complete, central spot large and projecting sharply towards base of wing, marginal spot smaller, separated, and forming with the 1st basal spot a very good representation of an exclamation mark (very clearly seen in fig. 2, Pl. XVI); marginal row partially present and indistinct; nervures finely lined with white; ground-colour mottled yellowish-brown, occasionally almost orange, replaced by black between the inner margin of the wing and nervure 2. The black bars on the fringes of all the wings very broad and even.

COMPARISON WITH THE OTHER SPECIES OF THE GROUP.—There is no one species in particular that *andromedae* can be said to resemble at all closely; nevertheless one not infrequently finds collectors who are not certain about this species, and who are liable to confuse it with *cacaliae*. The characters enumerated above should prevent any such confusion arising, when dealing with typical specimens; but with certain aberrations of *andromedae*, particularly those in which the white markings of the upperside of the fore-wings are reduced or obsolete, some trouble might be experienced. If, however, the characteristic features of the basal spots on the underside of the hind-wings are carefully



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Hesperia andromedae.

1. Upperside × 2. 2. Underside × 2.

Natural Size.

Lenzerheide (Grisons). 4. Pyrenees. 5. Troms.
ab. 3rd spot of discoidal series wanting. Gemmi Pass.
ab. 2nd and 3rd spots of discoidal series wanting. Lenzerheide.
ab. first three spots of discoidal series wanting. Kandersteg.

studied, one cannot think that any real difficulty will ever occur. Rarely specimens of *cacaliae* are found in which an imperfect exclamation mark has been developed, but though such specimens might be taken by an inexperienced person for *andromedae*, the converse should not be possible. It should be remembered that the ground-colour of the underside hind-wing in *andromedae* is replaced by black at the inner margin up to the 2nd nervure, and therefore the exclamation mark in *andromedae* is depicted on a black background, which is never the case in *cacaliae*. (This unfortunately does not show very clearly in the photographs.) Further, all the markings in *andromedae* on both upper and undersides are much more clearly and sharply defined than they ever are in *cacaliae*, and also the form of the basal spots on the underside is always squarer in *andromedae*, a very marked peculiarity; and lastly there is the presence of the 2nd basal spot, practically always present in *andromedae* and only extremely rarely so in *cacaliae*. There is in reality more likeness between *andromedae* and *centaureae* and *freija* than there ever can be between the former and *cacaliae*. This likeness has been already referred to, so we need only just note the chief points which distinguish *andromedae* here. These are to be found in the shape and size of the basal spots and the want of white outlining on some of the nervures on the underside of the hind-wing, and in the presence of spot 3 of the inner row on the upperside of the fore-wings. This latter is, however, by no means always present in *andromedae*, and, although a useful guide when it is, the collector should depend principally on the characters of the underside, which are really constant. *Andromedae*, too, is a larger insect than either of the others, and this difference is more marked than the measurements given would suggest.

Comparison with other Approximating Species of the Genus.—*Andromedae*, in common with the other species of the *centaureae* group, does not resemble any other species in a manner at all likely to produce mistakes of identification, in spite of the fact that some of the other species do produce aberrations which are a little suggestive of *andromedae*. These will be noted in their turn. So far as *andromedae* is concerned, a careful study of our figures (Pls. XVI and XVII) should be quite sufficient to prevent any specimen passing unrecognised, or being taken for any other species.

Sexual Dimorphism.—♂ with a costal fold on the fore-wings, ♀ without. Ground-colour of upperside in ♀ slightly browner than in ♂, especially in examples which have been some time on the wing. Very fresh specimens of the ♀ seem to be as black as the ♂, but the latter remain quite black even when badly worn. The ♀ is on the average a shade larger than the ♂.

Variation.—*Andromedae* is not a very variable species, and never produces really striking varieties, though minor aberrations are not infrequent. On Plate XVI, figs. 6–8 show a common form of aberration, that in which the first three spots of the discoidal series on the upperside are reduced in number or quite absent. In fig. 6 only two are present; fig. 7, one; fig. 8, the discoidal lunule alone remains of the series. As the photographs show, these aberrations occur in both sexes. Further aberrations of the markings of the fore-wings are seen on Plate XVII. Fig. 3 is a rare form in which there is a general tendency to reduction of all the white markings, often accompanied by an increase of grey scaling all over the upperside. The extreme form with grey suffusion is shown by fig. 1 (= ab. *perseus*, Schawerda) in which, with the exception of the basal area of the hind-wings, the whole surface is thickly covered with grey, but

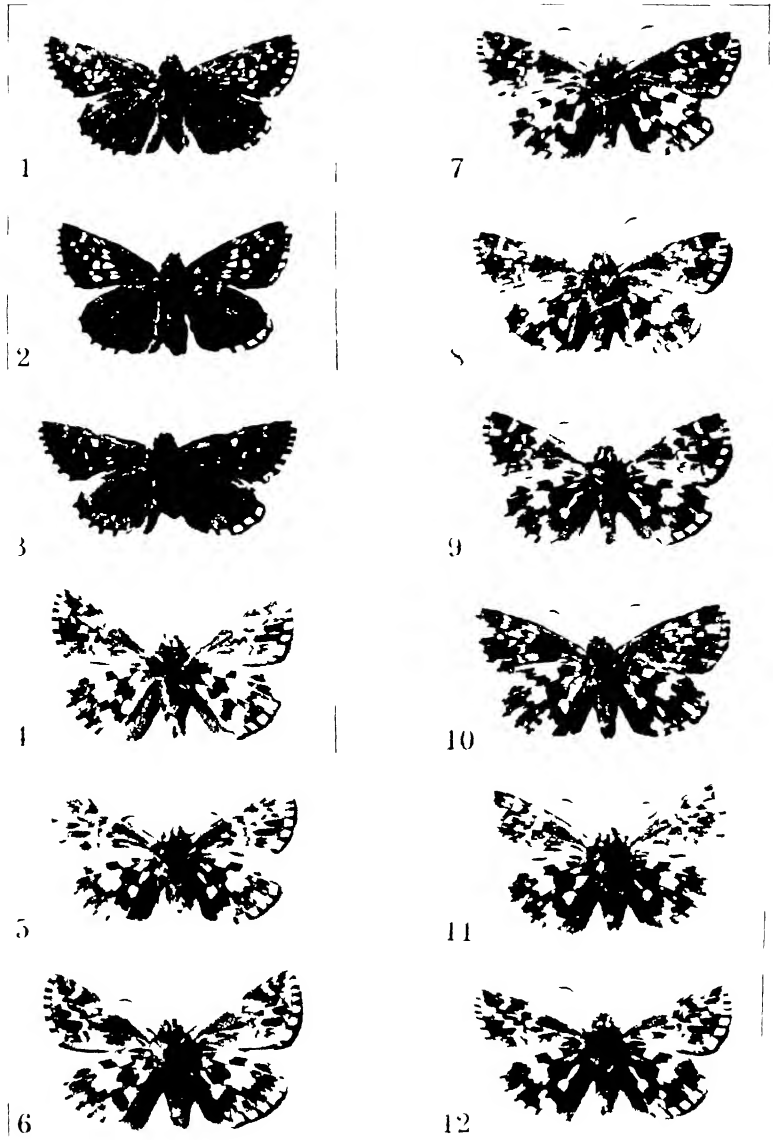
the white markings have remained typical. It is not a common form. In the direction of increase of white markings on the upperside there seems to be less variety. In all the collections examined, both private and public, there has been scarcely a specimen noted showing any marked increase of white, and in my own collection out of a series of 127 specimens there are less than half a dozen which show this form of variation. The most remarkable of these is shown on Plate XVII, fig. 2. As will be seen, the 3rd spot of the discoidal series and the 3rd of the median row are united on the left wing and almost so on the right, forming a curious wedge-shaped spot. On the upperside of the hind-wing the only variation consists of a slight accentuation of the spots of the median band, and this rarely attains sufficient prominence to attract attention. On the underside we find decidedly more variation, though always of a minor character. The form in which the two spots of the exclamation mark are united is perhaps the commonest; we illustrate several different degrees of this aberration. Occasionally they are united on one wing and not on the other (Pl. XVII, fig. 6), and frequently a further confluence of other spots accompanies this variation (figs. 6 and 7). In fig. 8 we show a rare form in which the 3rd basal spot and the costal spot of the median band are joined; it is the central spot of this band that is most frequently united to the 3rd basal spot. Strangely enough, however, this tendency to union in the spots of the exclamation mark is not always accompanied by a corresponding tendency among the other spots, but exactly the opposite; for, not at all uncommonly, a decrease in size is seen among the other spots, even the lower spot of the exclamation mark itself being sometimes reduced in size, although still united to the basal spot. The only aberration besides *perseus* which has been named seems to be :

ab. **reducta,** Warr.

The inner edge of the central spot of the median band on the underside, rectilinear, or very nearly so.

The extreme form of this aberration is rare in *andromedae*, though specimens in which there is only a very slight projection are not uncommon. Figs. 10–12, on Plate XVII are fairly well-marked examples. (Compare figs. 4–6.)

Date of Emergence and Duration of Flight Period.—The manner of emergence and the duration of the flight period in *andromedae* are of considerable interest. The species, to begin with, has the greatest vertical range of any of the alpine Hesperids; it may be seen from about 3500 ft. to about 10,000 ft., and very likely higher; added to this, the emergence at any given altitude is very irregular, so it becomes extremely difficult to form any exact opinion as to the true extent of time which can be said to be the normal flight period of the insect. For long, one has been accustomed to see July quoted as the time to look for the species, but the true state of things is, that, according to the altitude and the season, one can find *andromedae* on the wing from the middle of May to late in August. In 1920 I published an account of the emergence of the species drawn from personally made observations, and in view of the fact that our knowledge of this question is very limited, and that I have not been able to obtain any data worth speaking of from museums or private collections, I feel that it is essential to reproduce certain portions of my observations here. The emergence of the insect naturally becomes later as we ascend, but the extent to which it is retarded does not seem to be as great as would be expected. The following dates illustrate this. I have taken it on May 23rd at 3700 ft., on June 6th at 5200 ft. (both in the Bernese Oberland), a little over 5200 ft. on June 8th (Grisons), and over 6000 ft. on June 24th (Bernese Oberland), and



J. Bale, S. & D. Ltd. [illegible]

Hesperia andromedae

Natural size

1 (ab.) *perseus* Lenzerheide (Grisons)
2 ♀ (ab.) Dent du Midi
3 (ab.) Kandersteg
4 ♀ Rochers de Naye
5 ♀ Piz Palpuogna (Albula Pass)
6 (ab.) Rochers de Naye
7 ♀ (ab.) Lenzerheide (Grisons)
8 ♀ ,,
9 ♀ Rochers de Naye
10 ♂ (ab.) *reducta* Lenzerheide (Grisons)
11 ♀ Kandersteg
12 ♂

Sheldon took it on June 18th at Kolvisk in the Porsanger Fjord, which so far as climatic conditions go must equal an altitude of at least 7000 ft. These were all perfectly fresh specimens, and it seems probable that above 7000 ft. emergence will take place at the latest in early July. To conclude from the capture of one or two quite fresh specimens that the species is only just emerging is a very rash thing to do. I have taken a few specimens in various localities at high altitudes both fresh and worn in July, as, for instance: on the Grammont (Valais) at 7000 ft. July 19th worn, at Anthémoz (Valais) at 5800 ft. July 12th worn, same locality July 22nd fair and worn, Stätzerhorn (Grisons) 8400 ft. July 19th fresh, Parpaner-Rothorn (Grisons) about 7500 ft. August 1st fresh, Piz Palpuogna (Grisons) 7300 ft. July 22nd quite fresh; but from these records I would not venture to give an opinion as to when the species had commenced to emerge in those localities. The following dates will show why. They were the result of three months' almost daily observations in the neighbourhood of Kandersteg, two localities being kept under observation. The first was some marshy ground at an altitude of about 3800 ft. First specimen seen, a ♂ on May 25th, a few more on the 27th and 31st, several on June 2nd and 3rd, some worn on both these days; no others until June 29th when a few worn examples were taken, on July 3rd another quite fresh ♂, and again on July 8th one more fresh specimen, which was the last seen there. Throughout this period (May 25th–July 8th) the locality was visited almost daily. A collector going there daily from July 4th, and taking his first specimen on the 8th, might well have thought that the species was only just emerging, when in reality it was almost over. Again, in the Ueschinen Tal between 4600 and 5200 ft. :—First seen (after several previous visits to the locality) May 23rd; June 6th fairly common, both sexes; 8th some worn, 13th worn, 19th only one quite fresh, 24th fairly numerous fresh and worn; July 2nd a few worn, 6th one worn, 7th, 9th, 13th none, 15th and 16th a few fresh and worn, 19th one fair, 20th one fresh, 21st and 22nd one each day worn; the latter date being the last time I was able to visit the locality. Had I left on the 14th without having seen a single specimen for eight days, and remembering it had already been on the wing for six weeks, I should naturally have concluded it was over. At that date too (July 14th) it was well out, 1400 ft. above the locality under observation. Unfortunately I could not stay to ascertain for certain when it finally did disappear, but it seems hardly possible that it can have continued much longer. Two remarkable points are displayed by these two series of dates. The first is that at the lower level the flight period was shorter by at least a fortnight than at the higher. From this we may assume that the most suitable conditions for the species are those appertaining to the higher altitudes and latitudes. This is further borne out by what we have already noted in connection with *centaureae*; namely, that *andromedae* does not come so far south in the Scandinavian peninsular as does the former. The second is the extraordinary intermittent manner in which the species emerges. This naturally raises the question, How much so is this a characteristic habit of all the Hesperids? We are without the necessary data to answer that question in several cases, but in the remaining species we find nothing to suggest that this peculiar habit is at all usual.

Distribution.—Widely distributed in Europe, from the shores of the Arctic Ocean to the Pyrenees. In the Central European Alps it is one of the most universally distributed species of *Hesperia*, though the fact that it is only rarely abundant has given rise to the idea that it is a very local species. The

reverse is really the case, and almost anywhere in the Alps above 5000 ft. one may expect to find it. It requires, however, a good deal of looking for on the part of the collector, and a certain knowledge of its habits, lack of which may often result in total failure to find the insect. In both the Alps and Pyrenees the first essential, when looking for *andromedae*, is to find water, and to keep in the neighbourhood of it, a mountain torrent being a very favourite haunt of the species, though swampy ground of any sort is equally good. For this fact I offer no explanation, but I have proved it on countless occasions; yet against it one must set the remarkable fact that Sheldon has always found it in very dry localities in Lapland. His series of *andromedae* from that country, however, is not very large, and it is quite possible that it might have been much larger if he had looked for the species in wetter localities. The following localities give a fair idea of the wide distribution of the insect in Central Europe.

European localities :—

Austria.—Königsberg (British Museum coll.).

France.—Mont Cenis; Dauphine Alps (British Museum coll.); Lautaret (Chapman, Reverdin); Gabas; Gavarnie (Chapman); Col de Lurdé, Pyrenees (Warren); Porteille du Sisce; Ariège (Reverdin).

Italy.—Stelvio Pass (British Museum coll.); Trafoi (Tring Museum coll.).

Lapland.—Abisko (Sheldon); Porsanger Fjord (British Museum coll., Sheldon); Lapland (Chapman coll.).

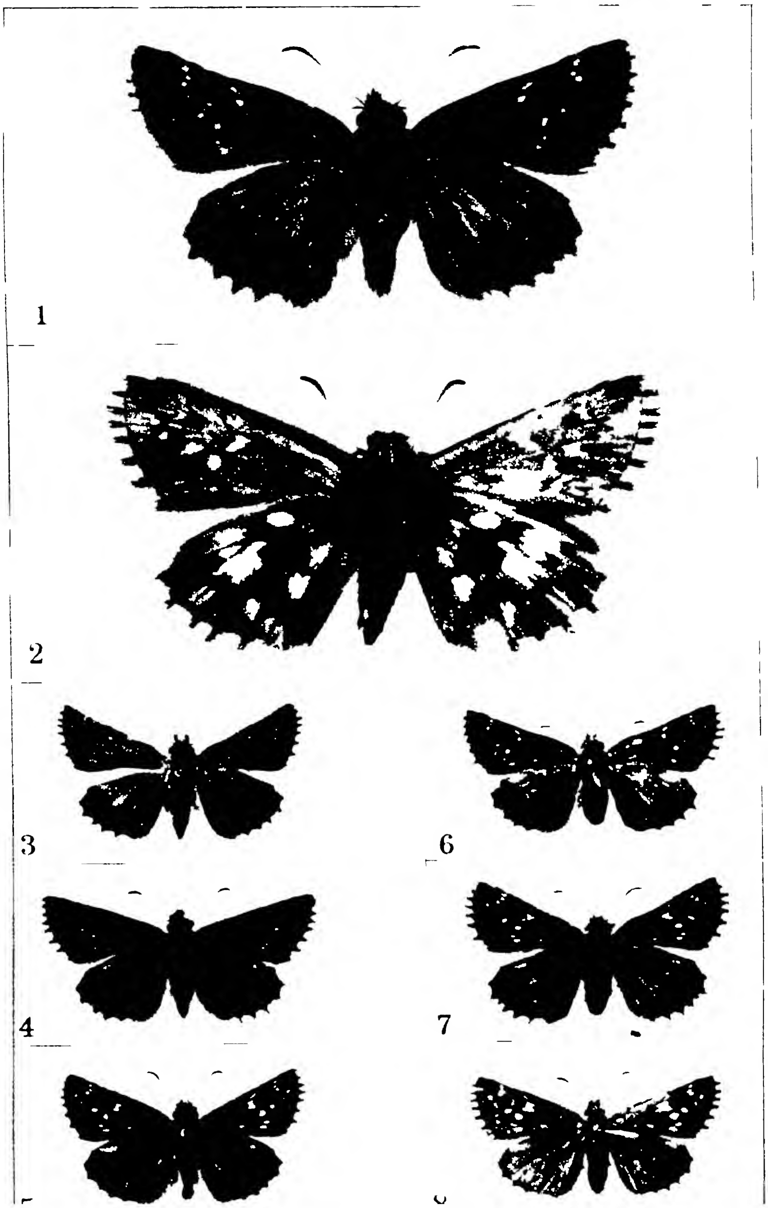
Norway.—Tromsö (Chapman).

Sweden.—Torne Trask (Chapman coll.).

Switzerland.—Albula Pass (summit); Bergün; Simplon Pass (Wheeler); Zermatt; Val de Nant (abundant); Zinal (Reverdin); Davos (Chapman); Kandersteg; Gemmi Pass; Rochers de Naye; Anthémoz (Dent du Midi); Grammont; Lenzerheide; Statzerhorn; Parpaner-Rothorn; Urden Furkli; Piz Palpuogna; Geisspfad Pass; Albrun Pass (Warren); Engadine (British Museum coll.).

Hesperia cacaliae, Rambur. (Pls. XVIII and XIX.)

Identification.—*Genitalia.* (Pl. XV, fig. 4; Pl. II, fig. 2.) The clasp in this species is developed on similar lines to that of *andromedae*, i.e. long and narrow, the greatest width centrally being just one-third of the length. The dorsal ridge strongly convex, the style broad and long, extending almost to the end of the clasp, its dorsal line continuing in the same curve as the dorsal line of the harpe. The subharpal plate of weak density but considerable extension; ventral plate wedge-shaped, with its greatest width at its proximal end, whence it tapers to less than half that width at its junction with the cuiller. Ventral line of cuiller extending in an unbroken curve to its extreme length, which, however, is a point considerably lower than the proximal apex, and in consequence the dorsal line of the cuiller is a gentle curve sloping down to the distal extremity; the apex is always on a decidedly lower plane than the dorsal edge of the harpe, usually more so than is the case in our photograph. The proximal edge of the cuiller rises in a curve exactly following the distal curve of the harpe, but nowhere touching the latter. Antistyle bluntly rounded. The clasp of *cacaliae* bears more resemblance in outline to that of *sidae* than any other species, but the fact that the style does not rise above the harpe but continues in the same plane as the latter will always serve to identify the species without recourse to any of the other numerous points of difference. A glance at figs. 4 and 5 on Plate XV will show how striking this apparently trifling distinction really is. To distinguish the species from *andromedae*, the form of the cuiller and ventral plate will have to be considered. The characteristics of these structures will normally not be difficult to observe, but a certain amount of variation occurs in the cuiller in *cacaliae*. It, on occasions, is almost flat dorsally, which is produced either by a lowering of the apex or a slight rise of the distal extremity. In spite of this, there should not be any real trouble in deciding to which species such a specimen



J Bale, S & D, Ltd Photos by C S Warren

Hesperia cacaliæ

1 Upperside × 2 ♂. 2 Underside × 2 ♂.

Natural size

3 ♂ Statzerhorn (Grisons)
4 ♂ Lenzerheide ,,
5 ♂ ,, ,, ,,
6 ♀. Urden Furkli ,,
7 ♀ Piz Palpuogna ,,
8 ♀ Parpaner Rothorn (Grisons)

belonged. The separation between the harpe and cuiller always remains in *cacaliae*, and is often considerably more pronounced than in our photograph; in *andromedae* it never is really noticeable, indeed, often it is hardly visible, although the harpe and cuiller are not united. Finally, the characteristic forms of the ventral plates are always reliable; I have never found any variation in this respect in either species. The collector, however, must be on guard against mistaking in *cacaliae* the ventral aspect of the subharpal plate, which is often apparently joined to the ventral plate, for the latter, which would then be apparently of unaltered width throughout. This, of course, it is not; our photograph (fig. 4) shows the lower edge of the subharpal plate as a dark line just over the ventral plate, the true form of the latter can, however, be plainly seen.

General features.—Size, 30–34 mm. *Upperside*:—Fore-wings: discoidal series never complete, usually only the 4th (discoidal lunule) present, and it is often in the ♂ reduced to a mere point and scarcely visible. Median row complete or incomplete, composed of more or less rounded spots, 5th most usually wanting; outer row wanting; discal spot wanting; subcostal spots incomplete, normally only one present, situated above discoidal lunule. Hind-wings without markings. *Underside*:—Fore-wings: all markings usually very indistinct; discoidal lunule and median row more or less visible. Hind-wings: basal spots incomplete, 1st small, somewhat narrow with suffused edges, 2nd wanting, 3rd large and more or less rounded; median band incomplete, no spots between nervures 2 and 4, central spot projecting slightly but sharply towards the base of the wing; marginal row fragmentary, usually one or two spots near the anal angle and one between nervures 4 and 6, other flecks of white present. Nervures faintly marked in the same shade as the ground-colour, which ranges from a light golden brown to orange, and extends from nervures 1*b* to 8. Black bars of fringes indistinct on all wings.

Comparison with the other Species of the Group.—*Cacaliae*, with its indistinct markings and washed-out appearance, is not likely to be mistaken for any other species of the group, which are all very distinctly marked. Nevertheless, an occasional strongly marked specimen of *cacaliae* may be found, and such a specimen might be taken for *andromedae*, though not by anyone who had any previous knowledge of the insect. The chief peculiarities of *cacaliae* are: the washed-out appearance of the underside of the fore-wings, the absence of the second basal spot on the underside, and the ground-colour of the underside of the hind-wings extending to nervure 1*b*. These points should make it impossible for anyone to mistake the species for *andromedae*, no matter how strongly or sharply it was marked. They equally prevent any possibility of confusion with *centaureae*, etc.

Comparison with other Approximating Species of the Genus.—Turning to those species of the genus which are outside the group, we cannot find any that in reality at all resemble *cacaliae*. In photographs a certain amount of similarity exists between it and *carlinae*, especially if we look at a specimen of *cacaliae* such as fig. 2, Pl. XIX, in which the spot between nervures 4 and 6 on the underside of the hind-wing is strongly developed, and a specimen of *carlinae* combining the double variation of loss of the 2nd basal spot accompanying a projecting inner edge to the central spot of the median band. (Such an ab. of *carlinae* is figured, Pl. XXXV, fig. 10.) In dealing with these insects themselves, however, the resemblance is almost non-existent. The much evener markings of *carlinae* and the strongly marked discal spot are quite unmistakable for *cacaliae*, and it is as rare to find a specimen of *carlinae* in which one cannot make out some trace of the 2nd basal spot as it is to find a specimen of *cacaliae* in which one can, and, finally, the yellowish-orange colour

of the underside of the hind-wings in *cacaliae*, even though it is variable, never makes any approach to the reddish ground-colour of *carlinae*. Of *serratulae*, perhaps a word should be said, as it often inhabits the same ground as *cacaliae*, and some ♀s of the former are very indistinctly marked and the formation of the basal spots is somewhat similar in the two species. In this case, however, as the last, the absence of the discal spot (always pronounced on the underside in *serratulae*, even if less so on the upper) and the 2nd basal spot, combined with the blurred underside of the fore-wings and softer outline of the markings in general, make the identification of *cacaliae* a simple matter.

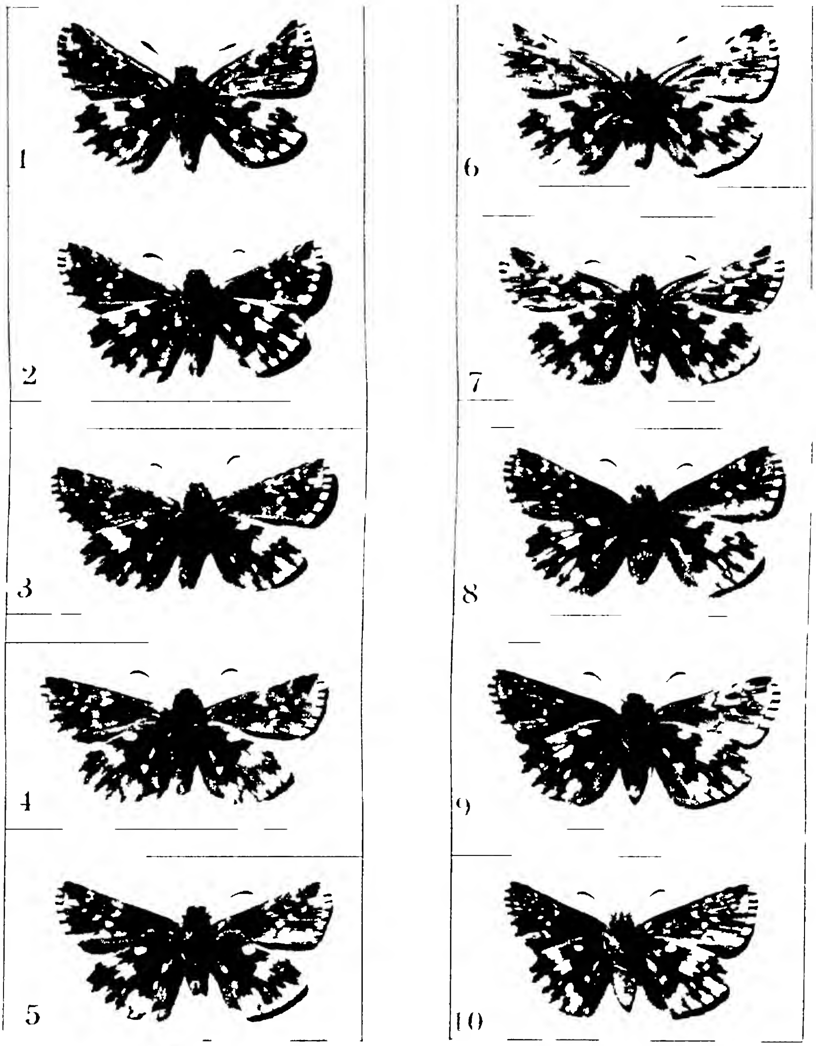
Sexual Dimorphism.—The ♂ has, and the ♀ has not, a costal fold on the fore-wings. The ♂ is as a rule less strongly marked on the upperside of the fore-wings than the ♀, and also has the ground-colour darker. The ♀ is usually strongly suffused all over the upperside with yellowish-brown scales, often with a greenish tinge. This suffusion is rare in the ♂, and, when present, seldom so extended, and of a greyish or yellowish-grey colour.

Variation.—There is a considerable amount of minor variation to be seen in *cacaliae*. Its habitat, being strictly limited to alpine regions, does not encourage the development of specialised races, which are unknown. The upperside is the most variable, that is, the upperside of the fore-wings, the hind-wings being practically without markings. What I regard as the normal form, *i.e.* that which is most frequent, is shown in our enlarged photograph, Pl. XVIII, fig. 1, and also by figs. 4 and 7 in the natural size. Starting from this point, we get variation in both directions, both increase and decrease, the latter being of far more frequent occurrence. Figs. 3 and 6 (Pl. XVIII) represent more or less the extremes of loss of markings in both sexes, though there is a ♂ in the British Museum coll. entirely without markings, and I have a specimen, also a ♂, in which only the 9th spot of the median row remains. These two specimens must, however, be regarded as extremely rare forms; out of close on 400 specimens of *cacaliae* which I have examined in various collections, they stand unique.

ab. **caeca**, Rev.

This name has been given to a ♂ similar to the two just mentioned: in the specimen figured with the original description of *caeca* only the 9th spot of the median row remains, and it is greatly reduced in size.

One not unfrequently hears it said that a collector has taken a specimen of *cacaliae* without markings, but, on examination, it invariably proves to be a specimen something approaching our fig. 3. It must be added, that in the photograph the white spots show more clearly than they do in the actual specimen, and specimens such as this are often thought at the first glance to be entirely without white. I know of no ♀ without white, or even as slightly marked as the ♂ in fig. 3. It is curious that, whereas in a strongly marked species such as *carlinae* the ♀s are frequently almost without markings, in this weakly marked species, with its strong tendency to obsolescence, the ♀ should still almost always retain a fair sprinkling of spots. In the opposite direction, that of increase, the ♀s come out much more strongly than the ♂s. Fig. 5, shows a very unusually heavily marked ♂, in which even a trace of the 1st spot of the discoidal series can be seen (a most unusual occurrence), but, even so, it is scarcely more strongly marked than the normal ♀. Fig. 8 gives the maximum development for the ♀, in which, in addition to the very heavy discoidal lunule, one can make out a very faint trace of the discal spot. On the



Bale S & D Ltd *Photos by C S Warren*

Hesperia cacaliae
Natural size

1 ♂ Simplon Pass
2 ♀ Stätzerhorn (Grisons)
3 ♂ ab *reducta* Lenzerheide (Grisons)
4 ♀ ,, ,, Parpaner Rothorn (Grisons)
5 ♂ ,, ,, Upper Engadine
6 ♀ Tschitta Pass
7 ♀ Lenzerheide (Grisons)
8 ♀ Piz Palpuogna (Grisons)
9 ♀ ab *reducta* Stätzerhorn (Grisons)
10 ♀ ,, ,, ,,

underside this variation of the markings of the upperside takes no effect, the greatest variation being found in the ground-colour of the hind-wing, the basal spots, and the central spot of the median band. As previously noted, the occurrence of the second basal spot is extremely rare. Sometimes some of the basal scaling gives a false impression that such a spot is partially present, such as can be seen in figs. 6, 8 and 10 on Plate XIX, but close examination soon shows that this is not the commencement of a true spot. So far only two specimens have come to my notice in which this second spot was definitely present.

ab. **reducta,** Warr.

The inner edge of the central spot of the median band on the underside quite or almost rectilinear.

This aberration occurs frequently, in varying degrees, as is shown in figs. 3, 4, 5 and 9 and 10, on Plate XIX. In spite of the flat inner edge to the central spot, these specimens still retain the undoubted appearance of *cacaliae,* largely owing to the somewhat variegated ground-colour. This latter can on occasions assume a much more even surface, usually accompanied by a duller and darker tone. Such an example is figured on Plate XIX, fig. 2, and though the dull brown colour appears the same as the usual shade in the photograph, the even distribution of the colour can plainly be seen, giving the specimen an unusual look. This, on the whole, is not a common form.

Date of Emergence and Duration of Flight Period.—The emergence of *cacaliae* commences between about the 10th of June and the end of the month, according to the altitude. Soon after the first specimens appear the species becomes common; it exhibits no tendency to that irregular emergence which is so remarkable in *andromedae.* It is entirely single-brooded, as would be expected in such a purely alpine species, the range of its greatest abundance being between 6000 and 8000 ft., though it probably ascends as high as any vegetation does. Its flight period lasts for at least five weeks, and very probably longer, for at the highest altitudes it is often to be seen in mid-August, and it is known on occasions to have been seen at these heights in late June and early July. Records from the highest altitudes are as a rule scarce in the earlier part of the year, for collectors seldom go to the 7000-foot level much before the middle of July. The available records, and such observations as I have been able to make myself, go to show that emergence in late June, even at these great altitudes, is not at all exceptional. I have seen it well out on the Gemmi Pass at 6200 ft. on July 1st, high on Piz Danis (Grisons) about 7000 ft. on June 18th, on the lower slopes of the Stätzerhorn about 6500 ft. on June 24th, at the upper end of the Val Roseg over 6000 ft. on July 1st, and above Anthémoz on the Dent du Midi over 6000 ft. quite worn on July 12th. Chapman records it from Davos on June 29th, and Reverdin from the Gr. Glockner on July 2nd; the latter is about the usual time, the bulk of the records collected being for the first week in July. This, however, probably gives one a truer idea as to the emergence of collectors than of *cacaliae.* Against these early records, there are numerous references to August. Heutal August 8th, Splügen Pass August 10th, Eggishorn August 15th (Reverdin); Lautaret August 5th, Hospental August, Simplon Pass August (Chapman); Urden Fürkli August 8th (Warren). These records seem to make it more or less certain that *cacaliae* must have an average flight period of fully five weeks.

Distribution.—*Cacaliae* is apparently confined in Europe to the Central and Eastern Alps. In Seitz's *Macrolepidoptera of the World*, Mabille states that it occurs in the Pyrenees, but I have not been able to find a specimen from those mountains in any collection. Of course, our knowledge of that range is much less perfect than of the Alps, and it may well be that *cacaliae* does occur there, but it still remains to be proved. In the Central and Eastern Alps *cacaliae* is widely distributed and usually common where it occurs, but it is much more local than *andromedae* and confined to higher levels, being seldom seen below 5000 ft. except in single specimens. It is not, however, at all restricted to the neighbourhood of water or marshy districts, as is the latter, being equally abundant in moist and very dry localities. The ♂s are often to be seen in considerable numbers on a moist patch on a path, but they can be found in equal numbers on a flower-covered alp nowhere near water.

European localities :—

Austria.—Carinthia, Stelzing; Tirol, Oetz Tal (British Museum coll.); St. Ulrich; Gr. Glockner (Reverdin).

Bulgaria.—Rilo Dagh (British Museum coll.).

France.—Lac d'Allos (Reverdin); Lautaret (Chapman, Reverdin); Larche; Val d'Isère (Chapman); St. Martin de Vésubie; La Mieje (Tring Museum coll.); Mont Cenis (British Museum coll.); Mte. Pelat (Oberthür).

Hungary.—Hungary (Chapman coll.).

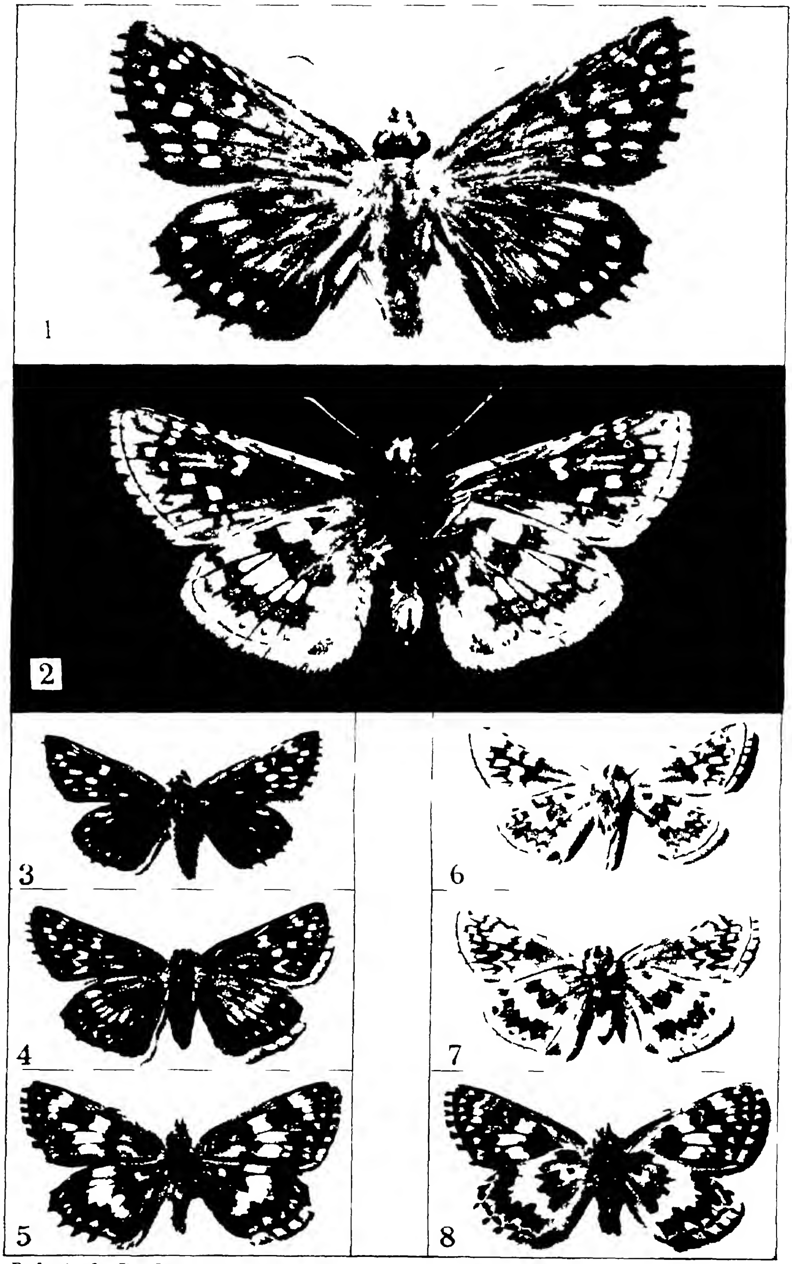
Italy.—Stelvio Pass (Reverdin).

Switzerland.—Furka Pass (Tring Museum coll.); Bergün; Engelberg (British Museum coll.); Heutal (Reverdin, Wheeler); Albula Pass; Bernina Pass; Schafberg, Pontresina; Roseg Tal; Simplon Pass; Steinenalp; Laquintal (Wheeler); Riffel Alp; Bérisal (Sheldon); Hospental; Val d'Hérens; Saas Fée; Davos; Fusio (Chapman); Julier Hospiz; Splügen Pass; Zinal; Eggishorn (Reverdin); Kandersteg; Gemmi Pass; Anthémoz, Dent du Midi; Stätzerhorn; Urden Fürkli; Lenzerheide; Piz Danis; Parpaner-Rothorn; Piz Palpuogna; Tschitta Pass (Warren).

Hesperia sidae, Esper. (Pls. XX and XXI.)

Identification.—*Genitalia.* (Pl. XV, fig. 5; Pl. II, fig. 1.) The clasp is another of the same type as *cacaliae*, roughly almond-shaped, its greatest width just one-third of its length. The ventral line is as strongly convex as the dorsal. The style very broad, and extending well above the dorsal ridge of the harpe before it is folded over. The proximal edge of the cuiller rises in a curve following the distal edge of the harpe, but set well back from the latter, leaving a fairly broad crescent-shaped gap between the two. The apex of the cuiller forms a sharp point, which is level with, or slightly higher than, the dorsal line of the harpe. Ventral plate of equal width throughout, being suddenly reduced at a point below the antistyle, where it unites with the cuiller. Subharpal plate strong and restricted to the central area. The likeness of the clasp to *cacaliae* has already been mentioned. The essential points which distinguish *sidae* are very easily observed. They are : the crescent-shaped opening between the cuiller and the harpe, and the sharp, hooked, apical termination of the former, the style standing high above the dorsal aspect of the clasp, the strong isolated subharpal plate, and the broad abrupt termination of the ventral plate. As nothing approaching this combination of characters occurs in any other species, they serve to distinguish *sidae* from all other species as well as from *cacaliae.*

General features.—Size somewhat variable. The smallest ♂ noted measured only 24 mm., the largest ♀ 44 mm. Both these measurements must be regarded as exceptional; the average size seems to be 32–38 mm. for the ♂s, and 36–40 mm. for the ♀s of the type form; the individuals of the subspecies *occidentalis* being on



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Hesperia sidæ and *Ramburia antonia*

1 Upperside, × 2 ♂ (Typical)

2 Underside 2 ♂ (s-sp *occidentalis*)

Natural size

3 and 6 ♂ Sarepta

4 and 7 ♀ Caucasus

5 and 8 *Ramburia antonia* Marghelan, Ferghana (♀)

the whole smaller, 30–36 mm. in both sexes. *Upperside*:—Fore-wings: discoidal series incomplete, 2nd and 3rd spots always, and 1st often, wanting; median row complete; outer row present, more or less distinct, but never sharply outlined; discal spot practically wanting; subcostal spots present, two in number, situated between the discoidal lunule and the 9th spot of the median row, and straight in line with the latter. Hind-wings: basal spots wanting; median band more or less complete and distinct, but always considerably suffused; marginal row complete and less suffused than the median band. *Underside*:—Fore-wings: discoidal series wanting except for the discoidal lunule; median row complete and sharply defined; outer row replaced by a white ante-marginal band; discal spot faintly visible; subcostal spots usually just discernible. Hind-wings: basal spots large, all present, 3rd more or less square, 1st and 2nd more or less run together; median band complete, central spot projecting sharply towards base of wing; marginal row forming a complete white band along outer margin of wing. All the white markings are outlined by a sharp black line; ground-colour bright orange.

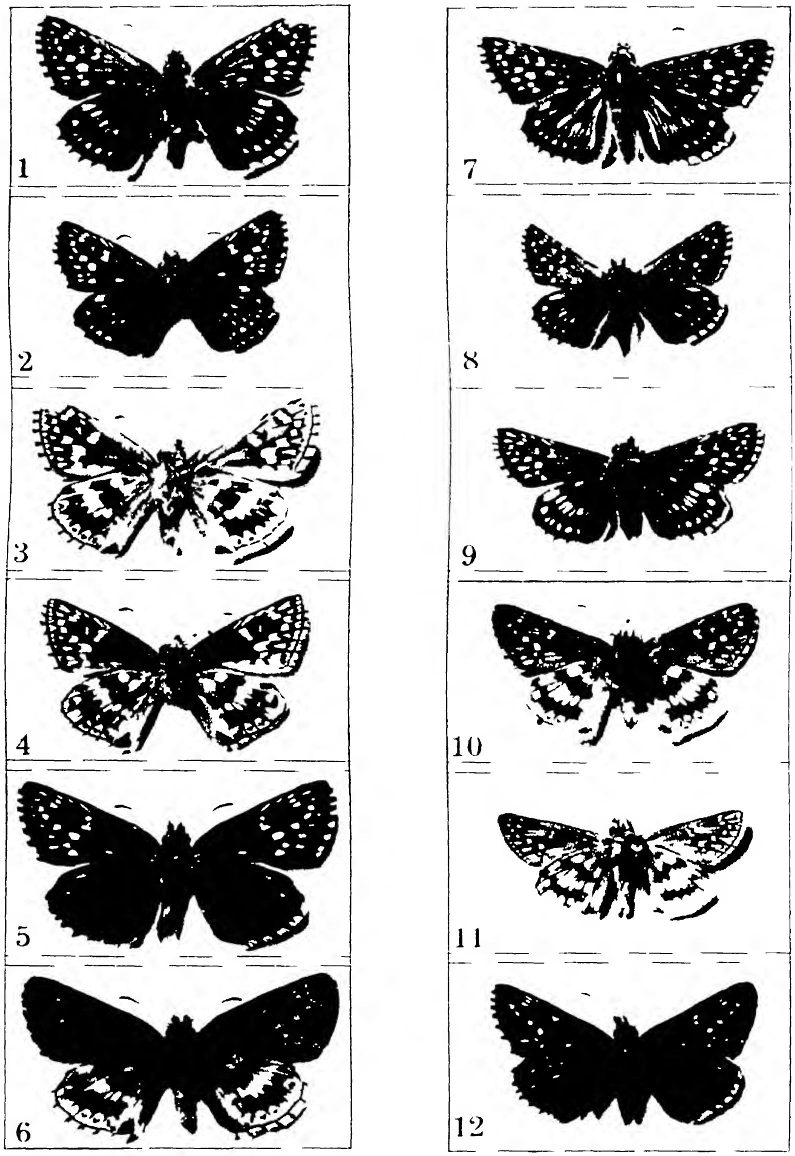
COMPARISON WITH THE OTHER SPECIES OF THE GROUP.—*Sidae* is remarkable in that it resembles another species, not a true *Hesperia*, more than any species of its own group. In every other case we find the greatest similarity existing between the species belonging to the same group, it being only the aberrant forms that make any close approach to the members of the other groups. *Sidae* can be distinguished at a glance from all the other species of the group by the brilliant orange bands of the ground-colour on the underside of the hind-wings.

COMPARISON WITH OTHER APPROXIMATING SPECIES OF THE GENUS, AND WITH *RAMBURIA ANTONIA*.—The same feature which distinguishes *sidae* from the other members of its group, namely the remarkable coloration of the underside, will prevent confusion arising between it and the other species of the genus. It is interesting to note, however, the great resemblance of the upperside of *sidae* to *H. carthami*, for no other species really bears any close resemblance to full-sized *carthami*. A large specimen of *H. serratulae* is sometimes very similar to a small specimen of *carthami*, but of course it could never be taken for a full-sized example of the latter. *Sidae*, however, might easily be mistaken for *carthami* on its upperside, if not examined too closely, as will be seen if fig. 1, Plate XX is compared with fig. 1, Plate XXII. The only difference is of course the position of the subcostal spots, in *sidae* extending one after the other along the costa from the discoidal lunule to the 9th spot of the median row; as compared with their position in *carthami*, immediately above the discoidal lunule. In direct opposition to this superficial resemblance on the upperside to a species very different on the underside, we get the extraordinary similarity of *sidae* on the underside to *Ramburia antonia*, a species not only very different on the upperside, but also entirely dissimilar structurally, a member of another genus. This resemblance has been commented on before, by both Reverdin and Chapman. *Antonia* not only has the same orange bands as *sidae*, but they are also outlined in black even more strongly than in *sidae*. In figs. 5 and 8, Plate XX (*R. antonia*), the want of colour makes the likeness less striking, but they demonstrate certain remarkable features (which will be referred to) very well, if compared with the photographs of the underside of *sidae* on the same plate. Chapman attributes this likeness to mimicry. He writes (*Ent. Record*, vol. xxix, p. 142): "The acquisition of this special colouring must have been entirely independent in the two species. In confirmation of this, we find that in *H. antonia* the white

and orange spots in front of vein 7 are reversed as compared with *H. sidae*; what are white in *sidae* are orange, what are orange in *sidae* are white, and there is, further, an orange spot, with black margin, in *antonia*, at the wing base, in advance of vein 8, an area without any marking in *sidae*. The result, however, is that, without analysing the actual arrangement, the disposition of the orange bands and spots seems precisely the same in both. The two species are, one of European, the other of Asiatic relationship, but their habitats are reported to extend in the one case eastward, in the other westward, to Turkestan. So that mimicry is not an excluded explanation, supported no doubt by an identical result produced by a different disposition of markings. It might, however, be held that similar markings were produced in the two species by similar forces, one acting in a European the other in an Asiatic area. In any case, it is fairly certain that the markings were separately evolved in the two cases, a similar generic constitution rendering a similar result from similar causes to be more easily produced, though it is difficult to believe such an identity of effect without actual identity of markings could be produced apart from mimicry."

In further confirmation of this theory, it is interesting to note that the eastern specimens of *sidae* approach more nearly in size and colour to *antonia* than do the western ones. The fact that Chapman accepted *antonia* as a *Hesperia* does not alter the value of his remarks, for as he was reviewing Reverdin's "Revision of the genus *Hesperia*" at the time of writing, he was dealing with the genus *Hesperia* in the very widest sense possible; and so when he refers to the "similar generic constitution" it was doubtless a phrase merely intended to express the certain affinity which exists between all the species of the tribe Hesperiidi. As a matter of fact, there is a closer generic constitution between the two than he can have supposed, for although *antonia* has become very widely separated from the members of the true genus *Hesperia* in that in the ♂ it has completely lost the 10th sternite and also the superficial characteristic of the remarkable angle in the median row of spots, yet it has retained the style, although in an extremely specialised form, and is the only species in the subfamily outside the genus *Hesperia* to do so. It is therefore unquestionably more nearly related to the species of the genus *Hesperia* than are any of the other species of the tribe, and so the similarity in generic constitution is stronger than Chapman thought when he accepted it as of equal value for all the black and white "skippers." Finally one may add, in support of the theory of mimicry, that there are several instances among the Hesperias in which we find local races of species that in their typical forms are very different, approximating very closely to one another; as, for example, the Spanish races of *carthami* and *alveus*, and the Pyrenean races of *carthami* and *serratulae*. In the former *alveus* is modified almost out of recognition to a very perfect mimic of a typical race of *carthami*; in the latter, it is *carthami* which is modified, especially in size, until in this respect it is almost exactly similar to the specimens of *serratulae* with which it flies. It seems to me impossible that anyone familiar with these insects in their typical forms in Central Europe can contemplate these remarkably altered races and the apparent models with which they fly, without being led to the conclusion that mimicry is the only agent which could have produced such a result. These races will be dealt with in detail under *carthami* and *alveus*.

Sexual Dimorphism.—The ♂ is on the average smaller than the ♀, and broadly dusted with grey on the upperside. This scaling does occur rarely



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Hesperia sidæ

Natural size

1—4 ♂ Cetinge, Montenegro

5 and 6 ♀ ,, ,,

7 ♂ s-sp *occidentalis* St Raphael

8 ♂ ,, ,, Hyères

9—11 ♂ s sp *occidentalis* Pont du Gard

12 ♀ ,, ,, ,, ,, ,,

in the ♀ also, but is usually confined to the basal half of the fore-wings. The hind-wings are more strongly marked with white on the upperside in the ♂, the latter also has a costal fold on the fore-wings which the ♀ has not.

VARIATION.—Perhaps the most striking and frequent form of variation in a series of *sidae* from any locality will be in the size; but taken on the whole there seems to be a decided decline in size as one goes from east to west. This gives rise to the western subspecies, but both it and the type race vary considerably in size.

s.-sp. **occidentalis,** Vty. (Pl. XXI, figs. 7–12.)

Verity merely notes that the race of Western Europe differs from the Russian one figured by Esper in being "much smaller, lighter in colour, and less boldly marked." This description might easily lead one astray, if only a few specimens of each form were available, for some large specimens of *occidentalis* are larger than small ones of *sidae* (see figs. 2 and 7, Pl. XXI). *Occidentalis* is, however, on the whole a distinct form. Averaging a smaller size, it is further distinguished by its finer markings. The white spots on the upperside are appreciably smaller and less square in shape, and the discoidal lunule narrower. On the underside they are also smaller, less heavily surrounded by black, and the black lines which edge the white on the hind-wings are also finer and the orange bands narrower. There is also an orange spot inside the 3rd basal spot; this spot is much more strongly developed than in *sidae*. While large specimens of *occidentalis* are fairly similar to *sidae* they have a noticeably paler appearance underneath, the dark markings being scarcely ever so heavy as in the latter; and in small specimens of *occidentalis*, all the white markings tend to decrease in size in proportion as the insect itself is smaller, which is not at all the case in *sidae*, where quite small specimens are almost as strongly marked as the largest ones. *Occidentalis* apparently replaces the type form west of the Adriatic Sea. There is apparently no other racial form of the species, but it shows a considerable tendency to aberrational variation. On the upperside we find much variation in the extent of the white markings. On the fore-wings the outer row may occasionally be almost absent, and occasionally reaches the other extreme, being developed into a series of very large and distinct wedge-shaped spots. The hind-wings, rarely, are entirely black, no trace of the median band or marginal row being visible. All these aberrations occur in both *occidentalis* and the type.

ab. **hafneri,** Stauder.

A remarkable aberration taken in June 1908 at Castelvechio in Dalmatia by Stauder, in which all the white markings of the upperside are reduced, with many spots quite obsolete; while on the underside the orange bands of the hind-wings are replaced by black. The latter remarkable characteristic is caused by the excessive development of the fine black edging which normally borders the orange bands.

ab. **reducta,** Warr.

Specimens with a straight inner edge to the central spot of the median band on the underside of the hind-wings.

This aberration is by no means common, but is found with both *occidentalis* and the type.

The orange bands on the underside of the hind-wings are often slightly

suffused with dark scaling; this is on very rare occasions developed to an extreme degree, producing a very remarkable effect, the bands appearing to be almost black. Apart from this suffused form the actual colour of the bands varies a good deal, ranging from light lemon-yellow to a deep orange; they also vary in width considerably, *occidentalis* producing the narrowest forms and *sidae* the broadest.

DATE OF EMERGENCE AND DURATION OF FLIGHT PERIOD.—The species seems to emerge everywhere sometime during May; earlier in the month in the southerly localities, and later in the more northerly ones. From the Riviera, Italy and Greece one finds most records refer to the first ten days of May; while from South Russia, the Balkans and higher altitudes in Greece, the most usual date seems to be some weeks later. The flight period lasts some five or six weeks, and one seldom sees a record of the species after the 15th of June, except from considerable altitudes, where it doubtless emerges somewhat later. In the Florence district Querci notes it as being usually over by the end of May, and as occurring in that month in the Aurunci Mountains; but I think the latter can only refer to the emergence of the species, for Reverdin notes it from Mt. Gibbio as late as June 8th; and Oberthür from Mt. Meta in the middle of July, the latest record I have been able to find. The only other July record is a specimen from Mt. Ararat taken on July 8th.

DISTRIBUTION.—*Sidae* in Europe is confined to the southern districts east of Spain, most frequent at low levels, but rising to well over 4000 ft. in some eastern localities. Probably much more universally distributed in Eastern Europe than the few records we have been able to collect would suggest. Widely distributed in Western Asia.

European localities :—

Bulgaria.—Slivno; Rilo Dagh (4000 ft.), (British Museum coll.).
France.—St. Baume (Tring Museum coll.); Draguignan (British Museum coll.); St. Raphael; Pont du Gard (Chapman); Hyères (Chapman, Sheldon, etc.); Cannes, Forêt du Dom; Mt. Pacanaglia; Bouches du Rhône (Oberthur).
Greece.—Aivasil Pass; Krusha near Paprat; Struma Valley (British Museum coll.).
Italy.—Mt. Gibbio (Reverdin); Alassio (Chapman coll.); Mt. Meta (Oberthur); Florence, Aurunci Mts. (Querci).
Jugoslavia.—Herzegovina: Mostar. Montenegro: Cetinje; Podgorica (Gibbs).
Russia.—Sarepta (Reverdin, Sheldon, etc.); Mt. Ararat (Reverdin).

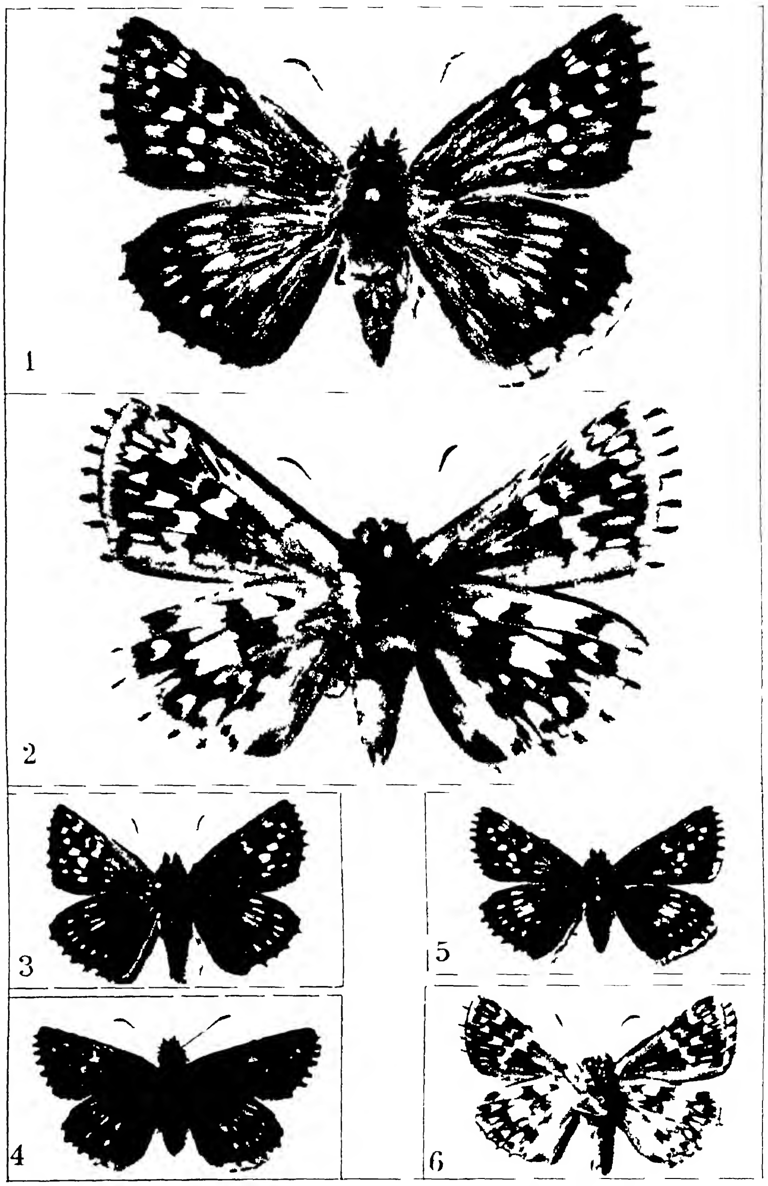
II. CARTHAMI Group.

STRUCTURAL CHARACTERISTICS.—Tenth sternite in male simple and entire; whole length of dorsal edge of harpe curved; style short and narrow, not folded.

CHARACTERISTIC FACIES.—Upperside fore-wing discal spot variable, more or less indistinct, never sharply outlined and rarely half the width of the discoidal lunule; central spot of median band underside hind-wing with uneven inner edge, projecting slightly, and bluntly, towards the base of the wing.

Hesperia carthami, Hübner. (Pls. XXII and XXIII.)

IDENTIFICATION.—*Genitalia.* (Pl. XV, fig. 6.) *Carthami* being the only European member of the group, the structural characters mentioned above will serve to identify it. As, however, it is a member of the subgenus ***Teleomorpha***



J Bale S & D Ltd Photos I C S Warren

Hesperia carthami

1 Upperside × 2 ♂ (s sp *valesiaca*)
2 Underside, × 2 ♂ ,, ,

Natural size

3 ♂ s sp *valesiaca* Branson (Valais)
4 ♂ ,, , Sierre ,
5 ♂ Piceno Central Italy
6 ♂ s-sp *valesiaca* Branson (Valais)

there is a certain amount of similarity in the armature to the species of the *centaureae* group, which are the only other European species in which we see the simple formation of the 10th segment in the ♂. It may be well therefore to note a few points of distinction between *carthami* and those species. The primary characteristic of the *carthami* armature lies, of course, in the style, which (by comparison) is short and stout, as opposed to the flat ribbon-like formation in the *centaureae* group; it curves simply over the terminal portion of the clasp without any trace of folding. The cuiller too is very simple in form, being almost straight and of equal breadth throughout. The subharpal plate is very thin and extended, so much so, that it is sometimes difficult to determine its area. It may be said, on the whole, that it nearly extends from the harpe to the ventral plate, which latter diminishes greatly in width as it approaches the cuiller, as in *cacaliae*.

General features.—Size variable, irrespective of sex, the largest noted being a Swiss specimen of 42 mm., the smallest a Pyrenean one of 28 mm. This difference could not be found in individuals from one locality. They represent the extremes of size from the localities which produce the largest and smallest races. The average size of the type form may be taken as 34–36 mm. *Upperside*:—Fore-wings: discoidal series incomplete, 2nd and 3rd spots wanting; median row complete and very pronounced; outer row variable, may be fully developed or quite absent; discal spot usually visible, more or less indistinct; subcostal spots present, two in number, situated over the discoidal lunule. Hind-wings: basal spots wanting; median band complete, more or less strongly defined; marginal row complete, usually fairly strongly developed. *Underside*:—Fore-wings: discoidal lunule heavily marked and distinct, as is the median row also; discal spot present, narrow, and not sharply outlined; other markings indistinct and variable. Hind-wings: basal spots present, 3rd the largest; median band complete, but broken between nervures 2 and 4, central spot with uneven inner edge, projecting bluntly towards the base of the wing; marginal row variable, three wedge-shaped spots next the anal angle each containing a small dark spot, the spots between nervures 4 and 6 united at their base, and divided into two sharp points at their inner extremity; an isolated spot between nervures 6 and 7 surrounded by the ground-colour, which is yellowish, mottled with darker shades, caused by the black scaling which is under the yellow showing through in places. Inner margin light grey shading to paler (often white) at its inner edge, to which the 1st basal spot and 1st spot of the median band are often united.

Comparison with other Approximating Species of the Genus.—As there are no other European members of the group besides *carthami*, we can turn to a comparison of the other species of the genus immediately. In the subgenus *Teleomorpha* we find no species really resembling *carthami*; the likeness of the upperside of *sidae* has already been mentioned, and does not need further comment. The underside of *carthami*, however, shows a few points which suggest that the development of a race of *carthami* fairly similar to *sidae* on the underside as well as the upper would not be so unlikely as might be supposed. In *carthami* the dark centres to the three spots of the marginal row next the anal angle are precisely similar to, only less developed than, the corresponding spots in *sidae*; there is also, on occasions, a tendency to the black outlining of the white spots of the hind-wings in *carthami*, and, finally, specimens with a very bright orange ground-colour to the hind-wings have been known to occur. A combination of these characters in pronounced form might easily produce a specimen very similar to *sidae* on the underside. The broken nature of the median band and marginal row, however, would not leave any real difficulty in naming such a specimen. Among the species of the subgenus *Ateleomorpha*, there are two which small specimens of *carthami* frequently resemble very closely. These two are *H. serratulae* and *H. alveus*.

To take the former first. In Central Europe there will not be so much chance of confusing *serratulae* and *carthami*, but in the southern area, in the Pyrenees and Spain where the smallest races of *carthami* occur flying with *serratulae*, it is often no easy matter to distinguish between the two. *Carthami*, however, can with care be recognised by the following characters. On the upperside of the fore-wings the 5th spot of the median row is always a little smaller than the others, but never very much so; and it ranges in size with the others, increasing or decreasing in size according as they do. The corresponding spot in *serratulae* is very much smaller than those below it; even when they are larger than usual, it is often absent. Further, on the upperside *carthami* is always fairly thickly covered with pale grey superscaling. On the underside in *carthami* the inner half of the inner margin of the hind-wings is almost white, and the 1st basal spot and the 1st spot of the median band are usually continuous with it; also the ground-colour of the hind-wings has a mottled appearance, being shaded unevenly with darker, especially round the white spots, sometimes even giving them a dark outline. These features will in most cases be sufficient to determine *carthami*. To turn to the second species—*alveus*. To most collectors of European butterflies it will probably seem absurd to say that there ever could be any difficulty in distinguishing between *alveus* and *carthami*, and of course with the typical forms of each there never could be; but it is so much a fact that in some races this difficulty does exist, that the first specimens of a certain subspecies of *alveus* were found in the collection of an eminent entomologist under the name of *carthami*. It is, however, the subspecies of *alveus* which is the variable quantity and approaches *carthami*, so it is not necessary to go fully into the matter at present, as it will be dealt with in our account of *alveus*. It is sufficient to note that some Spanish varieties of *carthami* are a little smaller than is typical of the species, and so lend themselves to furthering the similarity to the subspecies of *alveus* in question. As regards their facies there is nothing unusual to note. We may, however, mention the one sure character which can be relied on to separate *carthami* from this (? mimetic) Spanish subspecies of *alveus*, or any *alveus*, though of course elsewhere there is no lack of other characteristics. In *carthami*, on the underside of the fore-wings, the discal spot slopes down (away from the costa) to the bottom of the discoidal lunule, being as close to the latter, at the bottom, as it can be without touching it. In *alveus* the discal spot at its lower termination is set well clear of, and back from, the discoidal lunule. If any collector should consider this feature too small to be worthy of attention, and should find himself in a locality in Spain where he can capture that peculiar subspecies of *alveus* flying with *carthami*, his only means of identifying his captures will be by dissection.

Sexual Dimorphism.—The ♂ with a costal fold on the fore-wings, the ♀ without; the upperside of the ♂ thickly scaled with light grey, which is rarely present in the ♀; the ♂ also has a much blacker ground-colour upperside than the ♀, which is browner. The upperside of the ♀ is frequently dusted with yellowish-green, especially on the basal area of the wings, and also the ground-colour of the underside is of a deeper shade than in the ♂. The latter usually has more white markings on the upperside than the ♀, but this character varies extensively in both sexes.

Variation.—The variation of *carthami*, although limited, has attracted a good deal of attention, principally on account of the large size acquired by

certain races. Three racial names have been given to these large races at one time or another, but on close examination it is evident that there are in reality only two distinct races. The three names which we have in use in different publications are: *nevadensis*, Oberthür; *valesiaca*, Mabille; and *speciosa*, Verity. Of these, the two latter apply to the same form, and therefore *speciosa* falls to *valesiaca*.

s.-sp. **valesiaca,** Mab. (Pl. XXII, figs. 3, 4, and 6; Pl. XXIII, figs. 1 and 7.)

Mabille describes his "*valesina*" in Seitz's *Macrolepidoptera of the World* as inhabiting "the Valais and Tyrol," and having "the spots of the fore-wings less numerous, the hind-wings above being completely devoid of spots." That he was describing the race which he had already described as "*valesiaca*" in 1875 is certain, and one can only suppose the change of name to have been a slip. One thing is perfectly clear, the magnificent subspecies of *carthami* inhabiting the Valais cannot be said to be two different races, and though Mabille's description applies more to the ♀s than the ♂s, especially in regard to the markings on the hind-wings, nevertheless he intended his name to distinguish the race of the "Valais and Tyrol." As such, then, there is no question what *valesiaca* is. Three typical ♂s of the Valaisian form are shown on Plate XXII, figs. 3, 4, and 6, and a ♀ (which also is an example of the ab. *immaculata*) on Plate XXIII, fig. 1.

Verity describes *speciosa* as follows (*Ent. Record*, vol. xxxiii, p. 173): "The difference in size gives the impression that the Tyrolese race is gigantic; actual measurements between the wing-tips give 29, 31 and 33 mm. as minimum, usual, and maximum expanse in male, whereas the corresponding measurements in the nymotypical race are 25, 27 and 29; the difference between the few females I possess is not as marked, because the ones from the Tyrol are smaller than their males. The tone of colour of male is much deeper on both surfaces, chiefly because there is very little of the white dusting, often so extensive and conspicuous in the smaller race; also the white spaces are less extensive and they are notably so on hind-wing; on underside the fore-wings are distinctly black, instead of grey; the hind-wings are of a rich greenish yellow, with white spaces sharply outlined and bordered with brown; in the nymotypical race these wings are usually of a paler colour and the white spaces do not stand out so boldly."

This description applies very well to the Valaisian race (especially the remark relative to the underside), which differs from the type race just in the manner noted that *speciosa* does; though the restriction of white on the upperside which he refers to is the exception and not the rule. The measurements in Verity's description are unsatisfactory, as with the method of measuring between the wing-tips it is possible in a large specimen of *carthami* to get a difference of 5–8 mm., or even more, according to the manner in which the insect is set. However, as the difference between the measures Verity gives for the type and *speciosa* correspond to the difference existing between the true dimensions of the type race and the Valaisian race (*i.e.* 34–36 mm. for the former and 38–40 mm. for the latter, an increase of 4 mm. in each case), one can feel certain that *speciosa* and *valesiaca* are races of similar dimensions. These facts, taken with Mabille's statement that his *valesiaca* occurs in the Valais and Tyrol, make it quite evident that *valesiaca* and *speciosa* are one and the same. If any further proof was wanted, a subsequent remark of Verity's in the same article, to the effect that Oberthür's figure of *nevadensis* in the latter's *Et. Lépid. Comp.* "seems to resemble *speciosa*

in size and colour," would decide the question; for the figure of *nevadensis* might have been taken from a Rhone Valley specimen. Verity further remarks that the race of the S. Tyrol differs most constantly from the type, and that "not one specimen of either race could be mixed up with the other." This shows that *valesiaca* is a true subspecies in the Tyrol as well as in the Valais. The two enlarged figures of *carthami* on Plate XXII are done from *valesiaca*.

s.-sp. **nevadensis**, Obth.

Oberthür, in naming this subspecies, quotes Rambur's description of it as follows :—

"Les individus recueillis dans la Sierra Nevada diffèrent un peu de ceux de France, surtout par le dessous des ailes inférieures, dont la bord externe présente une nuance d'un roussâtre obscur, mais ne s'unissant pas complètement avec le dessin des ailes comme chez l'*alveus*; la tache de la massue des antennes est obscure ou noirâtre. Ils se rapprochent beaucoup de la variété de l'*alveus* de la même localité, mais ils s'en distinguent nettement d'après les caractères énoncés, et surtout par les différences très grandes des parties génitales." (Rambur, *Catalogue Systematique des Lépidoptères de l'Andalousie*.)

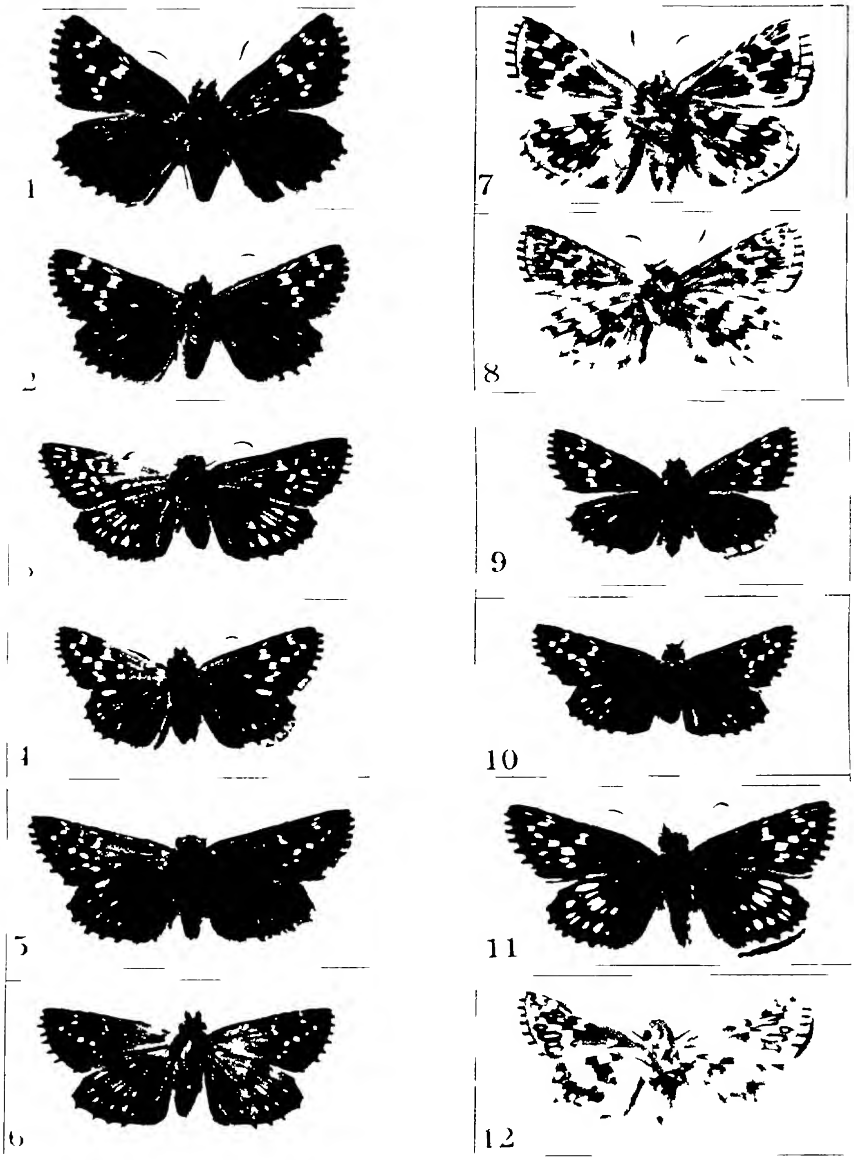
It is extremely interesting to see that Rambur was familiar with the extraordinary similarity of *alveus* and *carthami* in Spain; though of course it is *alveus* that approaches *carthami* in the Sierra Nevada, and not vice versa as he suggests, and as is the case in Central Spain. The character offered by the colour of the club of the antenna may be constant in the Sierra Nevada, but it is not in other Spanish localities; though the *carthami* of Central Spain differs so much in size from *nevadensis* that it quite possibly differs in this respect too. In *valesiaca*, however, from the Rhone Valley the colour of the underside of the club varies greatly, being sometimes almost black and sometimes almost as light orange as in *alveus*. Seeing how similar *valesiaca* and *nevadensis* otherwise are, I feel very doubtful if this character of the latter is any more constant than in the former, or, for the matter of that, in any other race of *carthami*. It is quite questionable if there is any true difference between *nevadensis* and *valesiaca*; Rambur's description suggests that there is, but Oberthür's figure, as already mentioned, might have been done from a Swiss specimen. In view, however, of the difference between *nevadensis* and other Spanish *carthami*, and allowing for the fact that errors have certainly crept into some of the figures in Oberthür's great work, it is probably wise to keep these varieties of the species under separate names.

On leaving the forms of *carthami* which have great size as their outstanding feature, we have another very interesting variety also of large size, but not extreme, which may be considered before turning to the smaller races; it is essentially an eastern variety.

s.-sp. **moeschleri**, Herr-Sch. (Pl. XXIII, figs. 11 and 12.)

In view of the conflicting descriptions which have been given of this subspecies, we give the original description of it.

"*Sidae.* Herr Lederer zieht meine *onopordi* sppl. f. 31–32, hieher, dann würde wohl auch *moeschleri* nicht davon zu trennen seyn. Sppl. 37, 38. Oben sehr ähnlich meiner abbildung von *onopordi*, grösser, vor dem saume der Vorderflügel schärfere weisse Längsstriche, die mittlere Fleckenreihe der Hinterflügel in Zelle 2 und 5 mit deutlicheren, gelben Flecken, durch dieselben merkmale auch von *carthami* verschieden, welcher die mittlere Fleckenreihe ganz fehlt. Unten fast ganz mit *carthami* übereinstimmend, nur sind die weissen



J Ind S D Ill *Hts K C S W*

Hesperia carthami

Natural size

1		s sp *valesina* ab *immaculata* Follaterre (Valais)
2		Budapest
3		(ab)
4		Canales (Logrono)
5		(ab) Digne
6	♀	(ab)
7	♂	s sp *valesina* ab *reducta* Branson (Valais)
8	♂	(ab)
9	♂	race *pyrenaica* Gavarnie
10	♂	
11	♂	s sp *moschleri* Sarepta
12	♂	,, ,,

Flecke aller Flügel etwas ausgedehnter und daher zusammenhängender. Sarepta." (*Systematische Bearbeitung der Schmetterlinge von Europa*, vol. vi, p. 175.)

This eastern subspecies differs from *carthami* principally by the very strong and clear white markings on the upperside of the hind-wings, the basal spots even (especially the 2nd and 3rd) being quite distinct; the extended and somewhat suffused white markings of the underside; and lastly by the presence of three ochreous spots on the upperside of the hind-wings, between the median band and the marginal row. These ochreous spots are not by any means constant, and are often quite absent or only very faintly visible. The subspecies is, however, quite the most specialised one of the species, and even without the ochreous spots always offers a striking contrast to typical *carthami*. The presence of the ochreous spots on the upperside is extremely remarkable and a unique character, as among the other palaearctic species of the subfamily HESPERIINAE such a thing is absolutely unknown. Most of the specimens of this subspecies, in public or private collections, come from the same locality as the type examples, *i.e.* Sarepta; but there are some in the Tring Museum coll. from Flamanda in Rumania, so it seems probable that it has a considerable range in Eastern Europe.

Occasional French specimens approach somewhat closely to *moeschleri*, some specimens from Digne even having one or two of the ochreous spots on the upperside of the hind-wings, though being otherwise fairly typical; while specimens with extended white on the upperside and one or two of the basal spots showing (though no ochreous spots) are more frequently to be seen. Some Italian specimens also develop these characteristics of the white markings. None of these specimens, however, are as pronouncedly marked as eastern *moeschleri*. They are nevertheless a similar form of variation, only carried to a lesser extreme, a fact almost always observable where we find the characteristics of a subspecies occurring in an aberrational manner.

These subspecies seem to be the only important ones to have received names so far. There remains one other racial form to be noticed, before considering the minor variation. This is the race of the Pyrenees, which may be known as :

race **pyrenaica**, nov. (Pl. XXIII, figs. 9 and 10.)

This race represents the opposite extreme to those we have been considering, being the smallest form of *carthami* at present known. Its average measurements are 28–30 mm., occasionally, however, a specimen of 34 mm. is found, *i.e.* typical *carthami*; for apart from size it does not differ from the type. This Pyrenean race is therefore but a race, and cannot be given subspecific rank. It is, however, an extremely interesting local production, being frequently difficult to distinguish from *serratulae*. Some mention has already been made of this race when considering the possibility of mimetic tendencies in the Hesperids. The actual measurements do not convey an impression of much alteration, but if the figures of *pyrenaica* are compared with the other illustrations of *carthami*, the difference will be very plainly seen; also the ♀ *serratulae* from the Pyrenees, figured on Plate XXVIII, fig. 8, will be seen to be only very slightly smaller (many Pyrenean specimens are as large as *carthami*, but the one figured is probably a fair average for the locality), while *serratulae* in many other localities is decidedly larger. Some Spanish varieties of *carthami* are a little undersized (fig. 4, Pl. XXIII, a ♀ from Canales shows this), but the difference is too slight to separate such varieties from the type.

On turning to the minor variation, among the named aberrational forms must be mentioned :—

ab. **reducta,** Warr. (Pl. XXIII, fig. 7.)

The inner edge of the central spot of the median band on the underside almost or quite rectilinear.

A fine specimen of this aberration belonging to the subspecies *valesiaca* is shown in our photograph. This variation tends to produce a look of *serratulae*, and, of course, when it occurs in race *pyrenaica*, the similarity is much stronger. It may also make identification somewhat difficult in eastern districts, where *serratulae* on occasions develops a considerable size; the distinguishing characteristics of *carthami*, however, which have been given already, are sufficiently constant to ensure correct identification, in spite of the alteration in the form of the median band.

ab. **vittatus,** Obth.

An aberration from Samoussy (Aisne), in which the median row of spots on the upperside of the fore-wings is very large.

This is a somewhat rare form, the development of the white spots is considerably above the normal of even strongly marked specimens.

ab. **duosignata,** Kilian.

A further development of *vittatus*, corresponding to the ab. *taras* of *H. malvae*. A very rare aberration.

ab. **immaculata,** nov. (Pl. XXIII, fig. 1.)

In this aberration the hind-wings on the upperside are without any white markings.

It is not very unusual in the ♀; our photograph shows a fine example belonging to the subspecies *valesiaca*, and it occurs also in the ♂; though extreme examples in the latter sex are decidedly rare. Along this line, and also as regards the loss of white on the fore-wings, one finds an extended range of variation. The type form of ♂ is represented by fig. 5, Pl. XXII, and that of the ♀ by figs. 2 and 4, Pl. XXIII. Fig. 3 (same plate) shows what is an unusual development of white on the hind-wings, for the ♀, excepting in the case of s.-sp. *moeschleri*, fig. 5, is more or less typical as regards the hind-wings, with considerably undersized spots on the fore-wings; fig. 6, a further stage of the same in which the hind-wings are also somewhat affected. All these forms are to be seen in the ♂ too, although they do not occur at all so frequently. The loss of any of the spots of the median row is extremely rare; I have seen specimens in which spot 5 was wanting, and possess two specimens in which spots 1 and 5 are absent.

On the underside a certain amount of variation is found, principally towards an increase in the size of the white markings on the hind-wings. Fig. 8, Pl. XXIII, shows an unusual form with the costal spot of the median band nearly touching the 3rd basal spot. In the same specimen, the marginal band is considerably more developed than is usual.

ab. **sidaeformis,** nov.

Specimens with the ground-colour of the underside of the hind-wings almost as bright orange as in *sidae*.

There is a fine specimen of this aberration in the Tring Museum collection. Specimens with a dark red-brown ground-colour are probably what Rambur described as *H. galactites*.

Date of Emergence and Duration of Flight Period.—The species is single-brooded, but is subject to a somewhat irregular emergence, which has led to its being recorded as double-brooded on many occasions. From late May to the beginning of August may be taken as the normal flight period of the species in lowland districts, and from late June, or early July, to late August in alpine regions. The late Canon Favre recorded it in April in the Rhone Valley, but there seems little cause to doubt that that date (if not entirely an error) can only have been some quite exceptional occasion, when he captured a single very prematurely emerged specimen; for so far, even from the most southerly localities inhabited by the insect, I have not been able to find a specimen which was taken before the middle of May, and in my own long experience of the Rhone Valley I have never seen a specimen of *carthami* before May 18th. The earliest records for lowland localities which I have been able to find are: on the Calabrian Coast May 19th (Querci), Croatia June 1st (Tring Museum coll.), Sierre May 26th (Chapman), Budapest May 30th (Sheldon), while the most usual dates are decidedly later; but when considering the latter one must remember that there is no means of telling how long the species may have already been on the wing. The following, however, are suggestive, in view of the complete absence of dates prior to late May, many of the localities being at a considerable altitude and many quite southern. Frankfurt June 1st, Courmayeur June, Albarracin June (British Museum coll.), Ste. Baume June 20th (Tring Museum coll.), Digne June, Fontainebleau June 28th, Tragacete July 18th–26th (Chapman), Zermatt July 14th, Schwalbach (Taunus Mts.) June 15th, Virton June 10th (Reverdin), Vernet-les-Bains June 18th (Gibbs), Albarracin June 6th, Martigny June 28th, Sarepta May 21st (Sheldon), Bérisal June 17th, Oberbozen June 8th (Wheeler). Thus we see that the species is on the wing at approximately the same time in such very different localities as Bérisal on the Simplon Pass, Virton in Belgium, Albarracin in Spain, and Sarepta in Russia. It is most probable that the presence of a few specimens in late August, in a late season, has been principally responsible for the idea that the species is double-brooded. In the high Alps it frequently can be found in early August, but in lowland localities, too, it occasionally can be seen far on in that month. Such specimens are, however, ones that have emerged late, most usually, though not invariably, ♀s, and are in themselves, without a knowledge of what has preceeded them, quite inadequate ground for maintaining *carthami* to be double brooded. One very late season I took two ♀s on August 22nd in the Rhone Valley, but they were so worn as to be almost unrecognisable. This is the very latest record I know of. Ten weeks is a long flight period for a *Hesperia*, and on occasions it seems that *carthami* may exceed that time; but it must be remembered that *andromedae* nearly equals it, and that the other species of *Hesperia* that are really double-brooded occur regularly much earlier and later (*i.e.* April and September) than *carthami* does.

Distribution.—Widely distributed in Europe, but rather uncertain how far north the species extends. Mabille gives St. Petersburg as its northern limit, but I can find no corroboration of this, though, in view of the scarcity of Russian records, one cannot place too much weight on this absence of evidence. Still, one would have more confidence in the St. Petersburg record if it had not been immediately followed by the obvious misstatement that the species was apparently absent from Greece and Italy.

European localities :—

Austria.—Tyrol (Reverdin).
Belgium.—Virton (Reverdin).
Bulgaria.—Bulgaria (British Museum coll.).
France.—Ste. Baume (Tring Museum coll.); Briançon; St. Martin Vésubie; Balma de Frema (British Museum coll.); Abriès; Lautaret; Col de Bretagne; Gèdre (Reverdin); Vernet-les-Bains (Gibbs); Gavarnie; Digne (Warren); Balsiège (Wheeler); Fontainebleau (Chapman); Samoussy; Mende; Florac; Cauterets; Angoulême; Vichy; Paris; Mont Dore; le Lioran; Garrabit (Oberthür).
Germany.—Stettin; Frankfort; St. Goar (British Museum coll.); Schwalbach, Taunus Mts. (Reverdin); Cassel (Oberthür).
Greece.—Greece (British Museum coll.).
Hungary.—Hungary (Tring Museum coll.); Budapest (Chapman coll., Sheldon).
Italy.—Oulx; Valdiere; Eggental (British Museum coll.); Sibillini Mts.; Calabrian Coast Range; Pizzo Tre Vescovi (Querci); Assisi; Villalago; Roccaraso; Sarnthal; Oberbozen (Wheeler); Aosta; Courmayeur (Chapman); Arco (Reverdin).
Jugoslavia.—Bosnia: Trebvie (Reverdin); Croatia: Zengg (Tring (Museum coll.).
Rumania.—Flamanda (Tring Museum coll.).
Russia.—Sarepta (Sheldon, Chapman coll.); Bagovitza (Podolia) (Chapman coll.).
Spain.—Albarracin (Sheldon); Sierra de Alfacar; Sila Mts. (Tring Museum coll.); Canales, Pr. Logrono; Tragacete (Chapman); Sierra Nevada (Oberthür); Tagamanent; S. Pere de Vilamajor; Guardiola-Bagá (Sagarra).
Switzerland.—Stalden; Chandolin (Reverdin); Zermatt (Reverdin, Chapman); Vissoye; Val d'Hérens; Glion (Chapman); Sierre (Sheldon, Chapman); Branson; Follaterre; Martigny; Vernayaz; Simplon Pass to Bérisal (Wheeler, Warren, Sheldon); Loèche (Sheldon, Warren); Fiesch; Binnental (Warren).

Subgenus HEMITELEOMORPHA, Warren.

STRUCTURAL CHARACTERISTICS.—Tenth abdominal segment in male greatly modified sternally, but still a complete circle, the sternite bearing lateral apophyses which are united ventrally.

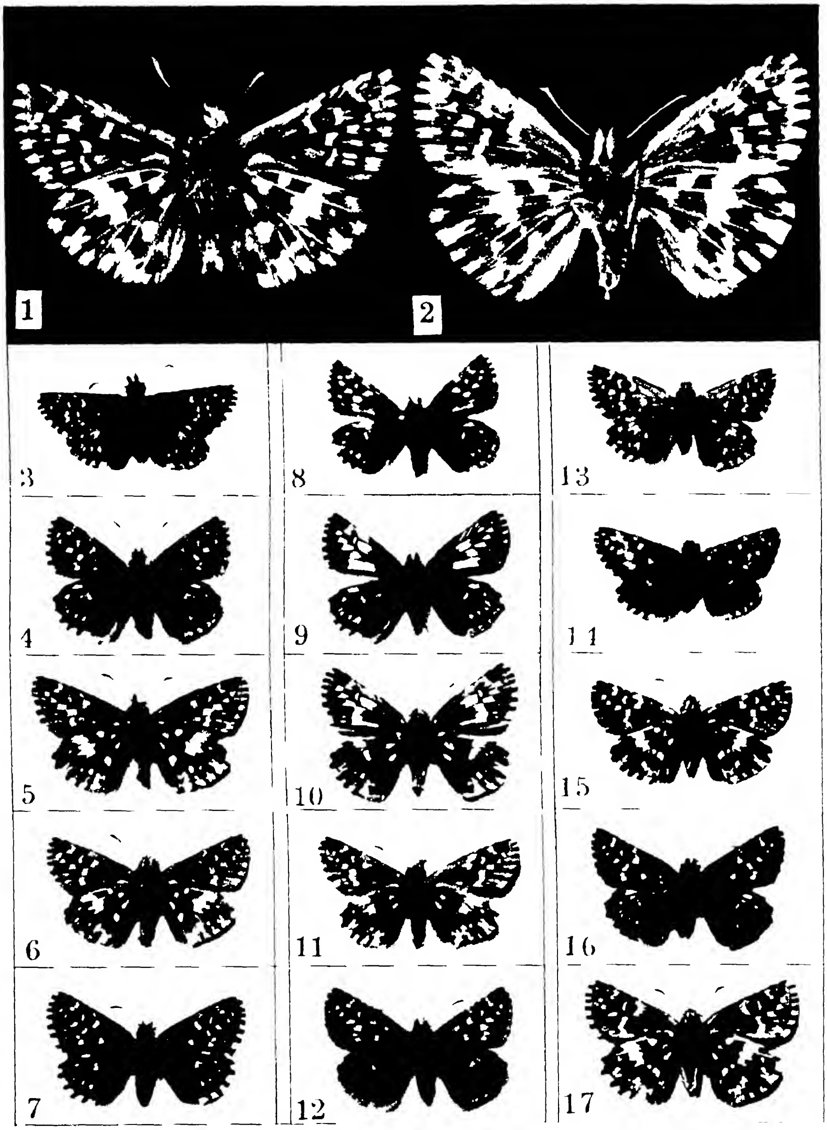
The species included in this subgenus are very specialised, and differ further from all other Hesperias by the absence of the subharpal plate.

CHARACTERISTIC FACIES.—We give the characteristic facies for the species of this subgenus as a whole, for they constitute one group, and not several, as in the two other subgenera, where we give the superficial characteristics for each group separately.

Upperside fore-wing discal spot distinct, broad, sometimes almost as broad as the discoidal lunule, sharply outlined if narrow; central spot of median band underside hind-wing with irregular inner edge, projecting slightly and sharply towards the base of the wing. Basal spots (especially the 3rd) of considerably less magnitude than spots of median band.

Hesperia malvae, Linnaeus. (Pl. XXIV, figs. 1, and 3–11.)

IDENTIFICATION.—*Genitalia.* (Pl. XXV, fig. 1.) In *malvae* the clasp has a much greater breadth than in the other species of the subgenus. The cuiller tapers from its base until it terminates in a sharp dorsal point; the style, which is very broad and short, also terminates in a sharp point, directed downwards, forming with the cuiller a remarkable likeness to the beak of a parrot. The dorsal edge of the style carries a row of sharp teeth over its entire length (considerably more marked than in the photograph); subharpal plate wanting; ventral plate very broad, almost half the width of the clasp. The lateral apophyses are broad, curving processes, in form not unlike a pair of ram's horns, united ventrally by a narrow, featureless, chitinous band, passing from the base of one apophysis to that of the other. The



J. Bale, S. & D., Ltd *Photos 1 and 2 A. T. Tonge. Others B. C. S. Warren*

Hesperia malvæ and *H. malvoides*

1. Underside, × 2 ♂ (*malvæ*) 2. Underside, × 2 ♂ (*malvoides*)

Natural size

3 ♂ *H malvæ* Saeterstoen 6 ♂ *H malvæ* Kandersteg
4 ♂ ,, ,, Glion (Vaud) 7 ♀ ,, ,, Budapest
5 ♂ ,, ,, Kandersteg 8 ♂ ,, ,, ab *bilineata* Caux

9 ♂ *H malvæ* ab *taras* St Triphon (Vaud)
10 ♂ ,, ,, ,, ,, ,, ,,
11 ♂ ,, ,, Kandersteg
12 ♂ *H. malvoides* Vernet-les-Bains
13 ♂ ,, ,, Lenzerheide (Grisons)
14 ♂. ,, ,, Canales. (Logrono)
15 ♂ ,, ,, Lenzerheide (Grisons)
16 ♀ ,, ,, St Maxime
17 ♀ ,, ,, Lenzerheide (Grisons)

uncus is bifid, consisting of two pieces which seem to be movably articulated to the tegmen. This characteristic of the uncus is unique, though rarely in *malvoides*, *melotis* and *pontica* we find a somewhat similar development. The great development of the ventral plate is remarkable, and obviously the result of the amalgamation of that process with the subharpal plate, which is wanting. No trace of the union is visible, but the nature of the dorsal element, when compared with the ventral, does not leave much room for doubt.

General features.—Size 24–30 mm. *Upperside*:—Fore-wings: discoidal series incomplete, 3rd spot wanting; median row complete, composed of small, very sharply defined spots; outer row faintly visible, more or less complete (very variable); discal spot distinct; subcostal spots present, situated above the discoidal lunule and discal spot. Hind-wings: basal spots wanting; median band incomplete, central and costal spots present; marginal row complete. *Underside*:—Fore-wings: discoidal series absent except for the discoidal lunule; median row clear; outer row present, but more or less indistinct. Hind-wings: basal spots present, small; median band incomplete, central spot with uneven inner edge, projecting slightly but sharply towards the base of the wing; marginal row fragmentary (variable). Ground-colour, various shades of yellowish and reddish-brown. Nervures outlined in paler shades.

Comparison with the other Species of the Subgenus.—There will never be any question of confusing *malvae* with *melotis*, the peculiar appearance of the underside of the hind-wings of the latter rendering any mistake impossible. With *malvoides*, however, it is very different. There are undoubtedly certain points by which given specimens of the two species can be identified, and that these characters are more prevalent in one species than the other is also true; but unfortunately the individual variation of both is so great, that with any number of specimens one can only hazard a guess as to the identity of any particular specimen. The characters referred to are four in number, and may be tabulated as follows :—

H. malvae.

I. Outer row of spots fore-wing upperside normally visible and fairly distinct, though not very sharply outlined.
II. Palpi darkish-grey when seen from below.
III. Club of antennae almost black when seen from in front.
IV. Ground-colour of underside hind-wings yellowish-brown, varying to reddish.

H. malvoides.

I. Outer row of spots upperside fore-wings wanting.
II. Palpi whitish-grey when seen from below.
III. Club of antennae golden brown when seen from in front.
IV. Ground-colour of underside hind-wings reddish-brown, varying to yellowish.

These points enable the specimens showing them to be identified, and sometimes a series of one species or the other will exhibit them in a very marked manner; but it is no uncommon thing to find specimens in which they are exactly reversed. This being the case, it is much wiser to depend on the data derived from the date of capture and locality for identification, if some alternative means to the difference in structure is required. It does not take very long to familiarise oneself with the distribution of both species in Europe, and once that is done, no further trouble in identification can arise, excepting in

regard to specimens taken near the northern boundary line of *malvoides*. In eastern regions our knowledge is insufficient to depend on locality alone, as the distribution of *pontica* is practically an unknown quantity.

Comparison with other Approximating Species of the Genus.—Outside the subgenus there are no species which at all closely resemble *malvae*. Its small size and the fine, sharply defined white markings of the upperside give it a very distinct appearance. Apart from this, the basal spots on the underside are very characteristic of the species, and a glance at these will prevent *malvae* (or any species of the subgenus) from being taken for any species of either of the other subgenera. The basal spots in *malvae* are small, and the 3rd especially so, usually the smallest of the three, never the largest. In practically all other species the 3rd basal spot is the largest. Further, the basal spots in *malvae* usually stand in the same class as the spots composing the marginal row, when compared, as regards magnitude, with the spots forming the median band; while in all other species the basal spots are in the same class as those of the median band, and, as such, equally superior to the spots of the marginal row. When looking at the magnified photographs on Plate XXIV, this is not so apparent, but if figs. 1 and 2 are compared with other magnified figures, it will become so. It is, however, quite plainly to be seen in the natural-sized figs. 5 and 6. It is a difference which is more conspicuous to the eye than the description would lead one to suppose.

Sexual Dimorphism.—The ♂ with, the ♀ without a costal fold. The upperside of the ♂ usually a little lighter than the ground-colour of the ♀, also moderately thickly scaled with pale grey; the white markings on the upperside of the ♀ appear to be more sharply defined than in the ♂, owing to the absence of the grey scaling, and there is also often a faint purplish tinge in the ground-colour of the ♀.

Variation.—The species is very variable, so far as minor varieties are concerned, but nowhere do we find any local race of subspecific standing. Many so-called races were named by Tutt, but they are not subspecies and they refer to *malvoides*. Tutt's account of the variation of *malvae*, in his *British Lepidoptera*, is confused and based on misconceptions, for which, for the most part, Tutt himself was not responsible. To start with, the fact that *malvoides* was a true species was unrecognised when Tutt was writing, and further, he was unacquainted with *melotis*, which, owing to a mistake, he believed to be a Swiss insect. Considering these points, one can of course not be surprised at the resulting confusion; unfortunately he made matters worse by describing as so-called "varieties" (*i.e.* subspecies) aberrational forms from various localities. His descriptions do not, and of course could not, give one any characters by which one could separate the forms he was naming from specimens taken anywhere else, for comparison of specimens from the localities he mentions shows that no differences exist. In this category come his vars. *alpina*, *andalusica*, *pyrenaica*, *melotis*, and *australis*; all of which, as it happens, are referable to *malvoides*. They will be further mentioned in connection with that species.

The principal lines of variation in *malvae* are: size; a tendency for the white markings on the upperside of the fore-wings to unite; the extent to which the outer row of spots on the upperside is visible; the coloration of the underside of the hind-wings; and the number and size of the white markings of the same. In all these particulars *malvae* varies endlessly, but absolutely independ-

ently of locality. To some of the most marked aberrations names have been given; before considering these we will take the one real racial form which is known.

race (? subspecies) **graeca,** Obth.

This race was described as a "variety," which leaves it an open question whether the describer considered it a subspecies or not; in all probability he did, but for want of any exact data, and in view of our knowledge of the species throughout the rest of Europe and the fact that typical *malvae* does occur in Greece and Asia Minor, it seems most probable that this is not a true subspecies, but only a race, so we maintain it as such until further information is available. It is a striking race, very much larger than the type, with the ground-colour of the underside of the hind-wings olive-green, and the white markings much reduced. In the figures Oberthür gives of it, the ♀ is almost the size of type *alveus*, the ♂ slightly smaller, and the colour of the underside is very remarkable. Habitat, Greece.

ab. **taras,** Bergstr. (Pl. XXIV, figs. 9 and 10.)

This is probably the best known aberration of *malvae*, and requires no description beyond the figures we give of it. The great increase of white on the fore-wings is accompanied by a reduction of white on both sides of the hind-wings. Principally a ♂ aberration; fully developed specimens of the ♀ are extremely rare.

ab. **intermedia,** Schilde.

An aberration in which the hind-wings have reduced white markings as in *taras*, but the fore-wings are typical.

ab. **pseudotaras,** Lacr.

Also forming a transition to ab. *taras*, but only on the underside, the upperside being typical. The amount of variation on the underside may be greater or less, but the specimen figured by Lacreuze (*Bull. Soc. Lép. Gen.*, II, Pl. III, fig. 5) might have been taken from an ordinary specimen of *taras*. Such extreme development on the underside only, with a normal upperside, is rather rare. Less pronouncedly marked specimens are of frequent occurrence.

ab. **scabellata,** Rev.

An aberration transitional to ab. *bilineata*; with spot 1 of the discoidal series united with spot 1 of the median row, on the upperside, thus forming a single white bar, which is often united at its two ends to the second spot of each series. Usually a fairly common aberration.

ab. **bilineata,** Rev. (Pl. XXIV, fig. 8.)

A rare aberration in which spots 1 and 2 of the discoidal series are united with spots 1 and 2 of the median row on the upperside, so as to form two parallel, but quite separate lines. Specimens in which these spots have formed a single white bar, usually united to spot 3 of the median row as well, are much commoner.

ab. **marginoelongata,** Rev.

In this fine aberration the outer row of spots of the fore-wings and the marginal row of the hind-wings, on the upperside, are developed into a complete series of sharply outlined, elongated spots, which quite fill the space between the median row and the margin of the wings, without being united to either. On the hind-wings the 2nd spot between nervures 4 and 6 alone retains the normal

shape, although somewhat elongated. All the other markings are normal. This aberration is somewhat similar to ab. *zagrabiensis*, but the spots of the marginal series though greatly enlarged are not united, and the fringes of the wings remain as in the type. The only specimens known are in the Reverdin collection, a ♂ and ♀, both from the Altai Mountains.

ab. **fasciata,** Tutt.

The hind-wings upperside with the white spots united to form a complete central band; the fore-wings typical. Not a very common form.

ab. **restricta,** Tutt.

Described as having both fore and hind-wings with distinctly reduced white spots, some being quite obsolete.

ab. **albina,** Tutt.

An aberration in which the ground-colour of both upper and undersides has become greyish-white, in place of the black. Named from a specimen in the Oberthür collection.

ab. **zagrabiensis,** Grund.

This is one of the most remarkable known aberrations of the species, described as being similar to the type in size and coloration, but with the spots of the outer row forming a complete, united white band, and the white markings on the upperside of the hind-wings obsolete, except for two narrow spots of the median band. The fringes of the fore-wings white, not chequered, with only one small streak of dark colour; those of the hind-wings with three streaks, which do not reach the outer edge, leaving the external half of the fringes quite white. On the underside of the fore-wings the outer row of spots is developed into a complete band as above, and the spots of the underside of the hind-wings are reduced in number, but larger than in the type.

ab. **reducta,** Warr.

The form in which the central spot of the median band on the underside has a straight inner edge.

This is a very common aberration, the projection from the central spot is always slight and a very little reduction makes it quite straight.

Date of Emergence and Duration of Flight Period.—Since the recognition of *malvoides*, the date of the flight period of *malvae* has become a question of great interest; especially as it serves as a help in the identification of the two species. *Malvae* is habitually regarded as single-brooded, and *malvoides* as double-brooded; but, in the light of recent discoveries, this view requires some qualification. Throughout the north-western zone of its distribution *malvae* is undoubtedly single-brooded; but in the eastern and southern regions it is certainly double-brooded, on occasions. In the British Isles, France, Switzerland and Northern Europe generally, *malvae* emerges in lowland localities in late April or early May, according to the season; and may be found on the wing until late June. In alpine regions up to 5000 ft. it appears about the end of May or early June, and can still be taken in July. Such are the normal times at which one may expect to find the species; but other records exist, which, if correct (and, in view of our knowledge of the distribution of *malvae*, there is no reason to suppose they are not correct), show that a second brood does occur; further, in the eastern region Graves has found that *malvae* is regularly double-brooded, occurring in the Constantinople district and in Asia

Minor in April and May, and in August. Specimens of both these broods have been dissected by Reverdin, so that there can be no doubt as to the fact. With this assurance of the possibility of *malvae* being double-brooded, and the knowledge we possess of the distribution of both *malvae* and *malvoides*, I can see no reason to doubt that in many parts of Eastern and Central Europe *malvae* is double-brooded, as the following records suggest, although specimens of the second brood have not been available for dissection. In several instances first-brood specimens from the localities mentioned have been dissected, and all proved to be *malvae*. It remains of course a very curious fact, and one for which no explanation seems available, that *malvae* should be single-brooded in localities like Norway, England and hot districts like the Rhone Valley in Switzerland and the neighbouring parts of France, while it is double-brooded, in between as it were, in Germany and Austria, and again in Asia Minor. Still, I see no reason to doubt the accuracy of the following records, so far as the actual occurrence of the specimens of the second brood is concerned. The following are selected from Tutt's *British Lepidoptera*. May, and again in July and August, Prussia (Schmidt); May and June, and August, commonly, Pomerania (Plötz); May and June, and September, Hamburg (Tessien); May and July, Göttingen (Jordan); April and May, and July and August, Crefeld (Rothke); May and August, Hesse-Nassau (Schenck); May and July, Frankfort a/M (Koch); May and June, and July and August, Berlin (Bartel); April to June, and August, Upper Lusatia (Möschler); May and August in the lowlands of Silesia, in the mountains only, June (Wocke); May and June and August, Bavaria (Hoffmann); May and June, and August, Württemberg (Keller and Hoffmann); to these can be added: August, one specimen only, Rennes (Oberthür); August, Vienna (Cooke); and doubtless many more similar records could be collected from German periodicals. In spite of these, it remains a fact, that in England, France and Switzerland, as well as the extreme north of Europe, *malvae* is absolutely single-brooded.

Distribution.—This is the most interesting subject connected with *malvae*. A species of great range, extending from Ireland to Eastern Siberia, from Scandinavia (62 N. Lat., Aurivillius) to Asia Minor, and yet wholly wanting in South-western Europe. In Western Europe *malvae* seems to occur everywhere as far south as the Alps, which apparently have checked its further spread; for it may be said to encircle the chain of the Alps on the north, east and west. In Western France, the southern limits of *malvae* are uncertain, but we have only one authentic record of it south of the 45th parallel; *i.c.* at Bordeaux. As one goes east, it recedes slightly northwards, occurring near Geneva; and then, crossing Switzerland on the north side of the main chain of the Alps, it passes round on the north side of the Eastern Alps, and extends far south down the Balkan Peninsula, to Greece and Asia Minor. Anywhere to the north of the Alps, nothing but *malvae* has so far been found; it would therefore be fairly safe to accept any records from northern localities without further confirmation. I have, however, in the following list of localities, still limited myself to those records proved correct, preferring to leave it to the future to complete the many gaps in the list, rather than to include any which might be misleading. Concerning the actual approach of *malvae* to the area inhabited by *malvoides*, no locality is yet known where the two coexist; but it remains quite possible that somewhere they do; the Tyrol or South-western France especially being districts where one might quite likely find a locality where the two species mingle. Up to the present, the closest proximity they are

known to attain is in the Rhone Valley in Switzerland, where between the hillside at Lavey-les-Bains where *malvae* flies, and Vernayaz the home of *malvoides*, a stretch of only five and a half miles separates the two species. It may be perhaps added that, on the road between Aigle and Sepey, a specimen of *malvoides* (proved by dissection) was taken by Sheldon. On this road *malvae* is common, as it is all round that neighbourhood. Sheldon's specimen was a solitary one, and in many years collecting all over that part of the valley I have never seen a specimen of *malvoides*, and this experience has been corroborated by the captures of every other collector I have met in the district. I think that one must conclude that Sheldon's specimen was accidentally imported, either as an egg or in the larval stage, from the neighbourhood of Martigny; no very difficult matter.

European localities :—

Austria.—Mödling; Wolfsberg; Koralp (Reverdin).

Denmark.—Common throughout (Bang-Haas).

France.—La Pape; Angoulême; Angers; Bordeaux; Rennes; Corbeil; Forêt de Carnelles; Mt. Revard; Marly; Monnetier; Mornex; Grand Salève; Tougues; Fonquevillers (Reverdin).

Germany.—Widely distributed and abundant (German authorities); Adlershof; Finkenkrug; Hamburg; Saxony; Waschau (Reverdin); Freiburg i/B (Warren).

Gt. Britain.—Throughout England and Wales, but exceedingly rare in Ireland and Scotland (Tutt).

Greece.—Greece (Reverdin, and Oberthür).

Hungary.—Czolusk (Reverdin); Peczel, Budapest (Chapman coll., Sheldon).

Jugoslavia.—Carniola: Laibach; St. Catharina (Reverdin). Croatia: Zengg (Tring Museum coll.). Montenegro: Cetinje (Gibbs).

Norway.—Saeterstoen (Chapman, Sheldon). The following given by Tutt in his *British Lepidoptera*: Naes Vaerk; Christiania; Odalen; Drammen; Fagernaes-im-Amdal; Valders (Siebke); Disenaen (Standen); Fredrikstad; Hvalöerne; Sireosen; Siredal; Ose; Valle; Larkollen; Roikenoiken (Strand); Hunneberg (Lampa).

Rumania.—Herkulesfurdö (Chapman coll.).

Russia.—Odessa; Orenbourg; Uralsk (Reverdin); Sarepta; Novorossisk (Sheldon).

Sweden.—Scania; Helsingland (Lampa); Lapland; Gottland; Ostrogothland (Zetterstedt). (From Tutt's *British Lepidoptera*.)

Switzerland.—Sonzier; Caux; Tinière Valley (Wheeler); Aigle (Sheldon); St. Blaise; Gadmen; Gryon; Versoix; Hermance; Grono; Bois Taille; Bois des Frères (Geneva) (Reverdin); Baden (Aargau); Kandersteg; Eclépens; St. Triphon; Glion; Rochers de Naye; Bex (north bank of Rhone); Lavey-les-Bains (Warren).

In this list the Scandinavian records from Tutt's *British Lepidoptera* were included, on the certainty that *malvoides* does not occur in Northern Europe. It will also be noted that no Italian records exist. In Reverdin's account of *malvae* and *malvoides* (*Bul. Soc. Lépidop. de Genève*, vol. ii, fas. 2), on the map he gives illustrating the distribution of the two species, one Italian locality for *malvae* is shown. This was an error, for Reverdin has never seen an Italian specimen, and no authentic Italian specimen is yet known, in spite of the many records of the capture of alleged *malvae* in Northern Italy. Even that most energetic collector and student of Italian Lepidoptera, O. Querci, has failed to discover an Italian locality for the species.

Hesperia malvoides, Elwes and Edwards. (Pl. XXIV, figs. 2 and 12–17.)

Identification.—*Genitalia*. (Pl. XXV, fig. 2.) In *malvoides*, the clasp is comparatively narrow, and there is no great central expansion as in *malvae*. The cuiller is irregular in outline, expanding slightly after it passes the harpe, and then tapering to a blunt terminal point. The style, broad and very short, curves gently

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Genus *Hesperia*, male armatures.

1. *H. malvæ*
2. *H malvoides*
3. *H serratulæ*
4. *H. melotis* (Typical)
5. ,, ,, (Abnormal)
6. *H onopordi*

over the apex of the cuiller. The antistyle is very short, and considerably narrower than the style, armed with a terminal series of teeth; the ventral plate, very broad at its proximal end, tapers as it nears the cuiller, and finally passes into that structure without any visible break or alteration. Subharpal plate wanting. The uncus is short and stout; the lateral apophyses of the 10th segment develop a slight rounded swelling, from which extends a straight spine of moderate length. From the ventral aspect of the apophyses extends a narrow chitinous band, which links the two apophyses together.

The formation of the uncus, lateral apophyses and clasp, is so very different from the formation of those structures in *malvae*, that with a well-mounted specimen one can practically recognise which species it is, with the naked eye. A moment or two's comparison of the photographs on Plate XXV, should enable anyone to recognise the difference between the armatures of *malvoides* and *malvae*.

Chapman noted that he had seen some examples of *malvoides* in which the uncus was bifid at the extreme tip, and we have already mentioned that this also happens occasionally in *melotis* (see fig. 5, Pl. XXV); such an extreme form as fig. 5 is, however, very rare, and the two sides of the uncus in both *malvoides* and *melotis*, though strongly suggesting that that process is formed of two pieces united, rather than one solid piece, are normally quite united to their termination.

The absence of the subharpal plate, as in the other species of the subgenus, is the result of its union with the ventral plate, and a faint line can be seen at what one would imagine to be the point of junction; nevertheless, the amalgamation is perfect, and the ventral plate is one solid piece.

General features.—Size 24–30 mm. *Upperside*:—Fore-wings: discoidal series incomplete, 3rd spot wanting, 1st and 2nd frequently united; median row complete; outer row wanting; discal spot distinct and sharply outlined; subcostal spots present, situated above the discoidal lunule and discal spot. Hind-wings: basal spots wanting; median band present (variable); marginal row present. *Underside*:—Fore-wings: discoidal series represented by the discoidal lunule; median row clear; outer row partially present; discal spot distinct. Hind-wings: basal spots present, small; median band incomplete, central spot with uneven inner edge, projecting slightly but sharply towards the base of the wing; marginal row fragmentary (variable). Ground-colour various shades of reddish-brown, varying to yellowish. Nervures outlined in a paler shade.

Comparison with the other Species of the Subgenus.—On account of the superficial resemblance of this species to *malvae*, it is unnecessary to do otherwise than refer the reader to our comparison of *malvae* with the other species. All the remarks made concerning *malvae* are equally applicable to *malvoides*.

Sexual Dimorphism.—The ♂ with, the ♀ without a costal fold on the fore-wings. The ♂ usually strongly scaled with light grey on the upperside, the ♀ with yellowish-green, though more often with scarcely any superscaling at all. As in *malvae* the ♀ sometimes takes a slight purplish tinge on the upperside, the white markings appearing to stand out more than in the ♂. The ground-colour of the underside of the hind-wings usually a little deeper in the ♀, but not at all invariably so.

Variation.—The variation of the species is precisely similar to that of *malvae*, every aberration described of the latter (excepting abs. *zagrabiensis* and *marginoelongata*) occurring in *malvoides* also.* In such cases it is simplest to retain all the aberrational names as applicable to both species. It will not be necessary to refer to these aberrations again here, but a few words must be said as to the so-called races which have been named. These have already been

* See Note (1), p. 161.

mentioned in connection with *malvae*; they are, Tutt's "vars." *alpina*, *andalusica*, *pyrenaica*, *melotis* and *australis*. The localities from which the specimens thus named came showed them to be *malvoides*. The "var." *melotis* was of course the result of an error, which will be explained in connection with that species. Between these "vars." there is no real difference, a slight difference in size being usually the only difference noticeable, which in this variable species counts for nothing, as the variation in size is considerable in every locality where the species occurs. I have compared specimens from all the localities mentioned, and it is perfectly safe to say that, were the data labels removed, it would be quite impossible to distinguish between them. It must of course, in fairness to Tutt, be remembered that he was comparing all these southern specimens (i.e. *malvoides*) with English and Scandinavian *malvae*, and therefore there was a certain amount of difference observable, but, as we know, not of a constant enough character to distinguish either individual specimens or the two species as a whole.

In comparing Tutt's descriptions and specimens from the localities he mentions, I was fortunate enough to possess, in many instances, the actual specimens he used. He describes the var. *pyrenaica* as follows: "Vernet-les-Bains, July 26th–August 11th, 1905. Two eastern Pyrenean examples from Oberthür, of good size, the ♂ slightly larger than the ♀, and powdered slightly with grey at base; both specimens of dark ground-colour, white spotting clear; both sexes with outer marginal row on fore-wings obsolete, on hind-wings also, in ♀ rather less than in ♂; in both sexes only the white discoidal spot of the hind-wings conspicuously marked. The underside of the hind-wings of the ♂ brown, of ♀ deep brown (inclining to chocolate); white spots not particularly clear in tint." The only points in this description which one can take hold of are the size, colour of underside, and absence of the marginal series of spots on the upperside, all of which can be found in *malvoides* from anywhere else, and of course are not constant features of the species at Vernet-les-Bains, or in that neighbourhood. I possess Tutt's type of the ♀, which is exactly the same size as the ♀ figured on Plate XXIV, fig. 16, from which it could not be distinguished on the upperside, except that the marginal row on the hind-wings is fainter. Underneath, it is curiously brown, especially the fore-wings, which Tutt does not mention. This latter feature shows the specimen to be an aberration, for I have a fine series of *malvoides* from Vernet taken by Gibbs, and some taken by Chapman, which are all absolutely typical in every respect, not a single one showing a tendency to become browner underneath. As to size, they are as variable as usual, and some are smaller than any on our plate. Further, I have a ♀ from the Rhone Valley which is the same brown colour underneath as Tutt's ♀, and somewhat larger. The fine ♂ shown, fig. 12, Pl. XXIV, is also from Vernet; it is the largest specimen of Gibbs' series, and has the marginal row of spots on the hind-wings quite distinct, as well as a fine red tone of ground-colour on the underside of the hind-wings.

The Locarno specimens described as *melotis* are noted as: "Locarno, April 1899 and 1903, and May 1902, both sexes especially black; the white markings of the fore-wings, particularly contrasting and reminding one somewhat of those of *carthami*; the hind-wings dark with very white spots, in some only a few spots, in others a well-developed transverse band; the underside olivaceous-brown, in some quite brown, well marked with white." Here the colour underneath and the reference to *carthami* are the only characters one can take as differing from any ordinary specimen. I have seven specimens from Locarno taken in May 1902, which if not the actual ones Tutt described (though I have

reason to believe they are) were at any rate taken in the same locality and at the same date. Of these seven, two have all the spots on the upperside of the fore-wings unusually large, which I take to be what Tutt was referring to, as reminding one of *carthami*; four are absolutely normal in this respect, and one has much finer and smaller spotting than is usual. On the underside the coloration is variable as usual. The two specimens with the large white spots on the fore-wings, and one normal one, have the underside of the hind-wings a reddish-brown, the others (all a little worn) show a yellowish shade; colours I could match perfectly in specimens from many localities. That the yellowish colour is not constant at Locarno is shown by three out of even so small a number of specimens as seven. The specimens with the heavy white on the fore-wings seem to be an aberration, there can be no question of their being a subspecies, yet Verity renames this form in the *Entomologist's Record* for 1919, and notes : " race *Tutti*, mihi. I propose this name for the very distinct race from Locarno, which Tutt described, but wrongly referred to *melotis*, a distinct oriental species." This name, of course, can only be accepted as an aberrational one. No such thing as a constant local race of *malvae* or *malvoides* (with the exception of race *graeca* of the former) has as yet been discovered; and this is not surprising or other than one would expect, when we remember that we cannot distinguish the two species themselves, superficially, with any certainty. I have dealt in detail with these two forms, as they can be retained as aberrations; Tutt's other " vars." cannot even be retained as such, representing merely specimens of variable size and with variable quantities of grey scaling and white markings on the upperside such as can be found wherever *malvoides* flies, and cannot be said to differ from the type as the characters themselves are indefinable.

It must not be thought from this criticism that I do not appreciate the value of Tutt's great work; quite the contrary; and, as I pointed out, slight differences were observable between these forms of *malvoides* and *malvae*, which naturally do not exist within the limits of *malvoides* itself; it was, however, impossible to deal with the variation of *malvae* and *malvoides* without referring to Tutt's work.

Of the named aberrational forms of *malvoides*, we have then, in addition to those already given for *malvae* :

ab. **pyrenaica,** Tutt.

This aberration may be described as having the underside of all the wings a rich brownish colour, approaching chocolate. Occurs at Vernet-les-Bains, but not confined to the Pyrenees.

ab. **tutti,** Vty.

An aberration occurring at Locarno (and elsewhere) with the white spots on the upperside of the fore-wings unusually large, but not uniting as in ab. *taras*.

ab. **semiconfluens,** Rev.

This aberration is described as having all the white spots on the upperside of the fore-wings considerably elongated, enlarged, and tending to unite; on the upperside of the hind-wings the white is reduced, only the marginal row (which is distinct) and the centre spot of the median band remaining; the latter is also reduced in size and is a mere line. The spots on the underside of the hind-wings are also reduced, and of unusual formation. The type specimen came from Praz de Fort, Valais.

No other variation of any importance occurs. Verity has given a separate name to the first-brood specimens in Italy. I have specimens of both broods from many Italian localities including Florence, and have examined them carefully, and compared them with first-brood examples from France, Spain and Switzerland, without being able to note any difference between them. All show the same range of variation, in a greater or less extent of grey super-scaling on the upperside, and in regard to size. Were the Italian examples mixed with those of other countries it would be impossible to pick them out again. The naming of these first-brood examples seems entirely superfluous, unless we accept it as necessary to retain a separate name for each brood of every species, whether the broods are distinguishably different or not.

Date of Emergence and Duration of Flight Period.—*Malvoides* is double-brooded, the date of emergence varying a good deal in different localities. It may be said that from early March to early June covers the period of the first brood, and from mid-July to mid-October the second. In the mountains it is single-brooded as a rule, appearing in June, July and August; but the occurrence of specimens in the Aurunci Mountains in different years in October (Mt. Aurunci October 6th, 1889, October 6th, 1909, Reverdin) seems to show that it can be double-brooded even at high altitudes, under suitable conditions; especially as I have specimens taken by P. Barraud in the Aurunci Mountains on June 23rd, 1910, at 5000 ft., so that the late occurrence the previous year did not prevent it from emerging at what must be considered (in view of the altitude) an early date the next. It is very difficult to estimate the actual length of the flight period, most of the dates collected referring to different years, none covering any length of time in a consecutive manner. The species emerges much earlier in some of the more southerly localities, as for instance Hyères March 1st, Pardignon March, Borme April 4th (Reverdin), as compared with Branson (Valais) May 8th, the earliest of many records I have from that locality. In these early localities the first brood is presumably over by May, the 2nd beginning in mid-July and lasting to September. Boréon October 17th (Reverdin) is a remarkable date, and might point to a partial third brood in a very early season, but considering the extended nature of the second broods of other species, and of the single brood of *carthami*, it seems most probable that it stands for an exceptionally late specimen, or specimens, of the second brood in a backward season. August is the most usual month for the appearance of the second brood, but there are many records of July too, *i.e.* Digne July 15th, Guéthary July 4th (Warren); Alserio July 20th, Trenno July 7th (Reverdin). In the alpine regions records for June are not uncommon, even at quite high altitudes, *i.e.* Simplon Pass June 24th, Laquin Tal June 27th (Wheeler), which, when compared with Stätzersee (St. Moritz) August 6th (Wheeler), and Simplon Pass August 5th (Reverdin), and Ofen Pass August 10th (Warren), shows that the species is probably on the wing for the best part of two months in those regions.

Distribution.—The distribution of *malvoides*, like that of *malvae*, is most interesting. Our knowledge of it is, however, still far from satisfactory. It is confined to the south-western corner of Europe, west of the Adriatic Sea, south of the main chain of the Alps, not coming further north in France than 45 N. Lat., and extending to the east of Portugal. Its north-east boundary is quite unknown; we have one authentic record of its occurrence in Carinthia on the Grödner Joch (Reverdin), but nothing further, and *malvae* also is found in Carinthia. This, however, must be about the most easterly point the species

reaches, for from numerous localities a little further east we get *malvae*, and so far we have no record of *malvoides* on the eastern side of the Adriatic. Its southern boundary is also uncertain. There is one record from North Africa (Lambèse, Oberthür), and Tutt gives one from Corsica (Ajaccio). None from Sardinia. Neither of these records has been verified by dissection. Seeing, however, that *malvoides* is common in Sicily and all along the coast of the Riviera, it is probable that it does occur in Corsica; but the Algerian record must remain doubtful, when we recall the distribution of *malvae* in Asia Minor and the eastern islands of the Mediterranean, and also that of *pontica*. *Malvae* occurs further south than Lambèse in eastern regions, and might well have extended into North Africa from there; so might *pontica*. One can equally suppose that *malvoides*, which occurs in the extreme south of Spain, might occur in Algeria; also that both species might do so. The question must remain open until we get a selection of specimens from numerous localities in North Africa for dissection. *Malvoides* extends to considerable altitudes in the Alps, possibly a little higher than *malvae* does. The highest points I have been able to note are the Riffelalp above 7300 ft. (Reverdin), and two specimens in the Chapman collection from the Campolungo Pass taken by H. C. Lang, and labelled by him 7500 ft.

European localities :—

Austria.—Carinthia: Grödner Joch (Reverdin).

France.—Cauteret; Argentière; Borme; Hyères; Pardignon; Antibes; Boréon; Cannes; Vence; Sarras; Folard; Morières; Mt. Ventoux; Lautaret; Uriage; Brides (Reverdin); Guéthary (Sheldon, Warren); Eaux Bonnes; Digne (Reverdin, Warren); Vernet-les-Bains (Gibbs, Chapman); Allos (Rowland-Brown); Gavarnie (Warren, Chapman).

Corsica: Ajaccio (Mann). (Not proved by dissection.)

Italy.—Alserio; Brunate; Porlezza; Rubiera; Alp Veglia; Casinalbo; Etruscan Apennines; Capo bianco; Farnesina; Farneto; Mte. Gibbio; Pratolato; Reggiolo; San Felice; San Clemente; Camaldoli; Rome; Subiaco (Reverdin); Siena (Wheeler); Aurunci Mts. (Barraud, Reverdin); Formia; Courmayeur (Chapman coll.); Florence; Mollarino Valley (Querci).

Sicily: Sicily (Reverdin).

Portugal.—Estrella (Reverdin).

Spain.—Evidently widely distributed, though verified records are not numerous. Cuenca; Canales (Logrono); Puerto de Pajares (Chapman); St. Lorenzo; La Granja; Sierra de Alfacar (Reverdin); Albarracin (Sheldon); Tarrassa; Vallvidrera; St. Llorens del Munt; St. Perre de Vilamajor; Guardiola-Bagá; Sta. Coloma de Gramanet (Sagarra).

Switzerland.—Bérisal; Simplon Pass; Gondo Gorge (Wheeler); Laquin Tal; Statzersee (Grisons) (Wheeler, Warren); St. Niklaus; Zinal; Pfyn Wald; Torrentalp; Praz de Fort; Riffelalp; Davos; Landquart (Reverdin); Fusio (Chapman, Reverdin); Martigny (Reverdin, Sheldon, etc.); Riffelberg (Sheldon); Locarno; Saas Fée; Hospental; Val d'Hérens (Chapman); Branson; Follaterre; Vernayaz; Salvan; Teufels Tal; Preda; Lenzerheide; Roseg Tal; Ofen Pass; Binn (Warren).

Hesperia melotis, Duponchel. (Pl. XXVI.)

Identification.—*Genitalia*. (Pl. XXV, fig. 4 (typical) and fig. 5 (abnormal).) The uncus swells out suddenly from the point of union with the tegmen, and then tapers to its extremity. In fig. 5 it is bifid at its tip, but this is most exceptional; normally it is united. Fig. 5 is a very remarkable example, and shows several other variations, too, in the form of the lateral apophyses, style, etc. The lateral apophyses are long and narrow hooked-shaped processes, somewhat as in *malvae*, but longer and much narrower and without teeth on their dorsal edge. Immediately below them, extending from their base, is a chitinous band, which connects the two

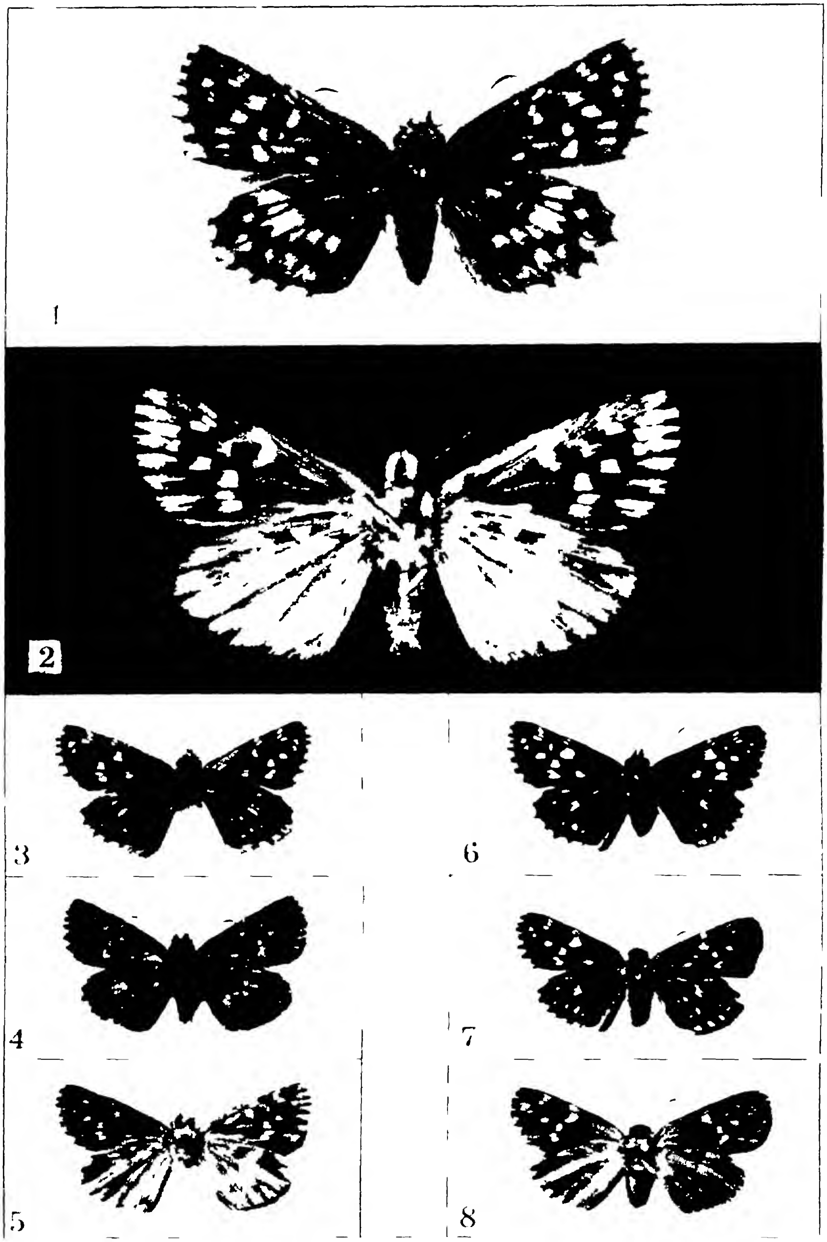
apophyses ventrally; the ventral portion of this band being much broader than the lateral parts which connect with the base of the hooks. From each end of the broad ventral portion rises another pair of hook-shaped processes, directed upwards underneath the large hooks. The latter pair of hooks are wanting in the abnormal specimen shown in fig. 5. The cuiller has but little terminal development, being almost the same width throughout and pressed tightly up against the harpe, while the latter rises considerably above the most elevated point of the former. The style, which is short and broad, curves out over the termination of the cuiller, being usually somewhat more upright than in the specimens figured. Antistyle long and narrow, bearing a series of pronounced teeth. Subharpal plate wanting. Ventral plate broad and tapering.

As will be seen, there are points of resemblance in this species to both *malvae* and *malvoides*, the lateral apophyses suggesting the former, and the clasp the latter. In spite of this, it is abundantly distinct from both. It is of course much nearer to the eastern species *pontica*, though the latter, superficially, is almost if not quite indistinguishable from the two former. Although outside the actual scope of this work, as *pontica* is not a European species, it may be interesting to note a few points of difference which distinguish *melotis* from the latter. In *melotis*, the large dorsal hooks of the lateral apophyses are of moderately even width throughout, only tapering gradually to the extremities; in *pontica* (Pl. V, figs. 5 and 6) they get considerably broader on the curve, and taper more rapidly. The small ventral hooks of *melotis* are strongly curved and fairly broad, while in *pontica* these processes are not hook-like, but straight spines of much smaller dimensions. Further, the termination of the cuiller keeps in contact with the harpe in *melotis*, and is set slightly back from it in *pontica*, and the style of the former usually rises from the dorso-distal angle of the harpe (sometimes even from the dorsal ridge), while in *pontica* it rises altogether from the distal aspect of the harpe.

General features.—Size, ♂ 28–32 mm. ♀ 32–36 mm. *Upperside:*—Fore-wings: discoidal series incomplete, 3rd spot always, and 2nd frequently wanting; median row complete, 5th spot nearer 6th than 4th; outer row wanting (first three spots rarely present); subcostal spots two in number, situated more or less over the discoidal lunule; discal spot present, of variable character. Hind-wings: basal spots usually wanting, 2nd occasionally present; median band complete, clearly defined, but the spots of variable sizes; marginal row complete, seldom very sharply outlined. *Underside:*—Fore-wings: discoidal series represented by discoidal lunule; median row complete; discal spot distinct, narrow; no further clear markings. Hind-wings: basal spots present, 3rd visible; median band complete, central spot projecting slightly towards base of wing; marginal row represented by four or five scattered spots; ground-colour yellowish-ochre broadly suffused with white, which sometimes traverses the wing in long rays from base to margin, sometimes more or less veiling the whole surface, always obscuring the markings. The actual colour of the suffusion, though white, often seems to be creamish, or even buff, owing to the ground-colour showing through.

Comparison with the other Species of the Subgenus.—Any lengthy comparison of *melotis* with the other species of the subgenus is quite unnecessary, the very remarkable appearance of the underside of the hind-wings, which is very well shown on Plate XXVI, renders the species quite unmistakable.

Comparison with *Tuttia tessellum* s.-sp. *nomas*.—Among the other species of the genus *Hesperia* there are none which are at all similar to *melotis* on the underside; but in the genus *Tuttia* the *nomas* form of *tessellum* has a similar type of underside, and, as *nomas* occurs in many districts with *melotis*, it may be worth while to compare the two briefly. To begin with, *melotis* is a much smaller insect, and the ground-colour of the upperside is a deep brown, never showing the least trace of the strong greenish tinge which is so conspicuous



J Bale S & D Ltd   Paris A L Longe   Others, B C S Warren

Hesperia melotis

1 Upperside, × 2. ♂   2 Underside 2 ♂

Natural size

3 ♂   6 ♂ (ab)
4 ♂ Syria.   7 ♀ Syria
5 ♂.   8 ♀ ,,

in *nomas*. Further, in *melotis* the outer row of spots on the upperside is never fully present, it is most usually quite absent, and if one or two spots are present they are faint and never clearly marked; and, finally, the ochreous ground-colour of the underside of the hind-wings is always visible through the white suffusion in *melotis*, whereas no coloration penetrates the white, which is of equal density all over the wings, in *nomas*. The underside of the fore-wings, too, is also considerably suffused with white in the latter, which is not the case in *melotis*.

Sexual Dimorphism.—The ♂ is on the average slightly smaller than the ♀, though very large specimens of the former are equal in size to the latter. The ♂ usually has a considerable quantity of light grey scaling all over the upperside of the wings, which is almost always wanting in the ♀ (it can also be quite absent in the ♂ on occasions), in which also the white spots of the fore-wings are very frequently larger than those of the ♂; although the outer row is never present in the ♀, occasionally it is partially represented in the ♂. Both sexes are very variable, and it is doubtful if any of these characters will enable one to pronounce on the sex of certain specimens. The ♂ has a costal fold on the fore-wings, which of course the ♀ has not.

Variation.—The variation of this species seems to be entirely of a minor character; no marked local races have been described, in spite of its remarkable distribution, though we must remember that the distribution is more scattered than widely extended, which does not lead to the production of numerous forms. Lederer's *hypoleucos* is indubitably indistinguishable from *melotis*, and there is nothing in the descriptions of the two forms which could be taken as a racial distinction. The variation in the coloration of both upper and undersides is considerable, many ♂s being extensively scaled with light grey all over their uppersides as in our fig. 1, Plate XXVI. Against these, one finds specimens in which the ground-colour stands out clearly, almost entirely free of such scaling, as in fig. 6, the specimen having in consequence more the appearance of a ♀. On the underside, the extent to which the hind-wings are veiled varies in every possible degree; figs. 2, 4 and 5 give some idea of this, but 4 is not quite the extreme form of reduction. The size of the spots on the upperside is also very variable, the heavier type of markings being more usual to the ♀, but as fig. 6 shows, it is by no means confined to that sex. There seems to be little tendency to loss of spotting on the upperside, the marginal row alone showing variation in this direction, and to a very slight extent at that, no specimen with the margins of the hind-wings entirely without markings having come to my notice. The markings on the underside of the hind-wings are apparently not so variable as is often the case, but it is difficult, sometimes impossible, to form an accurate opinion on this point, on account of the white suffusion. The central spot of the median band is, however, just as variable as that feature in *malvae* or *malvoides*. Most frequently it projects slightly towards the base of the wing, but we often find the form with the straight inner edge, *i.e.* ab. *reducta*, Warr.

The number of the basal spots is also variable; the 3rd alone, normally, being visible, but the 2nd on occasions can also be fairly clear. It must be noted that the material at our disposal is very limited, and entirely composed of eastern specimens. It seems very possible that the Spanish form of the species would differ pronouncedly from these, but I have been unable to get any Spanish specimens, or to meet anyone who has ever seen a Spanish specimen. When we recall that the few other species which have a similar

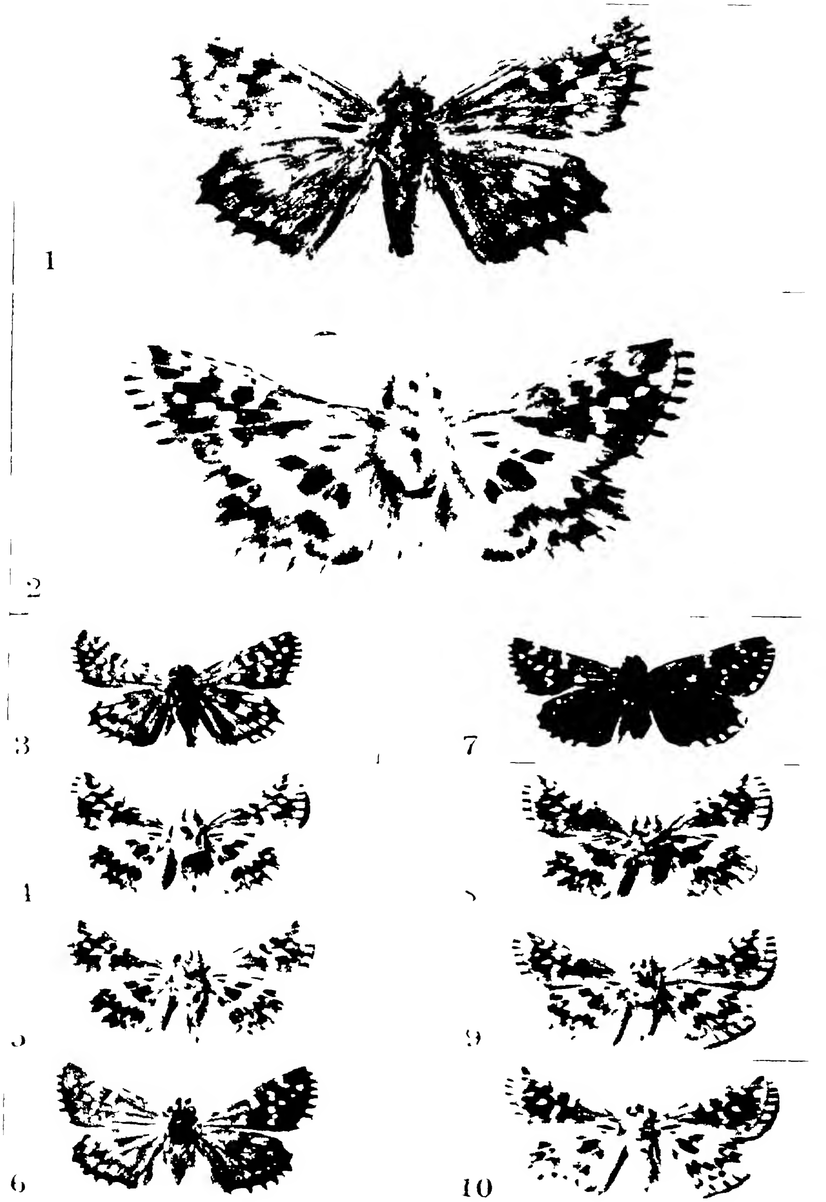
immediately over the discoidal lunule; rarely two, the second immediately above the first. Hind-wings: basal spots wanting; median band more or less complete, heavily suffused with darker scales; marginal row complete, also heavily suffused. *Underside:*—Fore-wings: first three spots of discoidal series wanting, discoidal lunule broad and distinct; median row complete; discal spot sharply defined; ground-colour blackish, setting off the white markings very distinctly. Hind-wings: basal spots all present; median band complete, central spot anvil-shaped, projecting strongly in a single very sharp point towards the base of the wing, and also as a double prong towards the outer margin; 1st spot, next to the inner margin of the wing, hollowed on its inner edge so as to assume a forked appearance, and projecting in a strongly pointed or rounded tooth from its outer edge towards the outer margin of the wing. This projection from the outer edge is not from the centre of the spot, but an extension of the outer half of the spot, along nervure 1*b*. Marginal row incomplete, usually represented by three V-shaped spots next the anal angle, and one square spot between nervures 4 and 6. Ground-colour mottled various shades of reddish-brown, often inclining to orange. First and central spots of median band usually finely outlined in black, basal spots more rarely so. Nervures outlined in a paler shade of the ground-colour, and not conspicuous. (Owing to the lighter shade on the nervures, they become unduly prominent in the photographs, and strike the eye more than they do in reality.)

Comparison with other Approximating Species of the Genus.—The identification of *onopordi*, when only considering the species of the subgenera *Teleomorpha* and *Hemiteleomorpha*, offers no difficulty; all the species of the former are not only much larger, but are also of totally different coloration on the underside. In the latter, we have *malvae* and *malvoides*, which are somewhat similar to *onopordi* in respect of the colour of the underside, and though *onopordi* is on the average a larger insect, some small ♂s are no larger than *malvae*. On the upperside of the hind-wings *onopordi* shows a different type of facies, such white markings as are visible being broad and of soft outline, much suffused with darker scaling. This contrasts very markedly with the small, sharply defined and clear markings of the hind-wings in *malvae* and *malvoides*. On the underside, too, many features of the hind-wings readily distinguish *onopordi*. The size of the 3rd basal spot, the continuous median band and the inconspicuous nervures, all contrast very distinctly with *malvae* and *malvoides*.

On turning to the subgenus *Ateleomorpha*, the majority of species are quite distinct from *onopordi*, but three resemble it fairly closely in size and colour of the underside; they are *armoricanus*, *carlinae* and *fritillum*, and they will have to be considered in turn.

Armoricanus is undoubtedly the species which is most likely to be mistaken for *onopordi*, and vice versa; for not only is it similar in size and colour, but it occurs at the same seasons of the year as *onopordi*, and frequently flies on the same ground.

Onopordi is best distinguished from *armoricanus* by the following characters:—Upperside hind-wings: the spots of the marginal row are squarish and of a spreading nature, inclined to run into one another, never circular in form nor at all sharply outlined. Underside hind-wings: the formation of the 1st and central spots of the median band, as already described; the united character of the spots composing the median band all more or less running into one another, the white often covering the nervures, always encroaching on them, making them scarcely visible where they cross the band. The spots between nervures 2 and 4 being almost always present and large enough to maintain the continuous appearance of the band, even if they are suffused



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Hesperia onopordi.

1. Upperside, × 2. 2. Underside × 2.

Natural size.

3. Alassio (September).
4. Follaterre (Valais) (July).
5. ab. *reducta*.
6. (? Digne).
7.
8. Branson (Valais) May.
9. Corsica (?).
10. Monte Meta, Central Italy (August).

with darker scaling. In such cases, a close examination often shows the band to be continuous under the dark scaling, though this might not have appeared to be so at first. The dark outlining to the basal spots and median band, and more or less inconspicuous nervures, completes the list of reliable characters which will distinguish *onopordi.* Specimens in which the central spot of the median band has a straight inner edge will of course be very similar to *armoricanus* (see fig. 5, Pl. XXVII), but knowing that such specimens can occur, the outer edge of the central spot should always be carefully looked at, for it retains its characteristic features even though the inner edge is modified. The other characters mentioned also remain reliable; if fig. 5 is looked at carefully, it will be seen that the median band is continuous under the dark scaling, and that the apparent break is of a very different nature to the break which exists in *armoricanus* (compare figs. 2, 5 and 6, Pl. XLVI).

As regards *carlinae* and *fritillum*, *onopordi* does not, in any real sense, resemble the former, though certain specimens of that species are often suggestive of *onopordi.* In this case, however, date and locality should be sufficient to prevent mistakes occurring. *Onopordi* is rare in alpine regions, and as a rule does not reach the altitudes at which *carlinae* is found. In the event, however, of a collector finding both species on the same ground, the points just enumerated as distinguishing the species from *armoricanus* should serve equally reliably in the case of *carlinae.* It may also be noted that the ground-colour of the underside in *onopordi* is hardly ever so deep and rich a shade as that normally seen in *carlinae.*

As to *fritillum*, the same distinctions apply, and, in addition, the much finer nature of the white markings on the upperside in *onopordi* may be noted as a characteristic never seen in *fritillum.*

Sexual Dimorphism.—The ♂ is slightly smaller than the ♀, with a black ground-colour on the upperside, strongly scaled with pale grey. The ♀ is much browner, with less scaling, what there is of it being of a yellowish-green colour. The ♂ has a costal fold, the ♀ has not; the white markings on the underside of the hind-wings of the latter are often broader than those of the ♂.

Variation.—The variation of *onopordi* is seldom of a striking nature, the species showing no real inclination to develop local races, specimens from the most widely separated localities such as the Atlas Mountains, Digne and the Rhone Valley in Switzerland being identical.

race (and form) **fulvotincta,** Vty.

This is a variety of the second brood, in which the ground-colour of the underside of the hind-wings is a deeper and redder tone; by no means the only form of the species found in the second brood in Europe, though it appears to be so in Africa.

The name was given to the second-brood specimens from Central Italy. Verity's description is, however, inadequate; it reads: "*H. onopordi* second gen. *fulvotincta*, mihi. Similar to the corresponding summer form of the preceding species" (*armoricanus*). His description of this form of *armoricanus* is, "the great majority of individuals of the second brood differ from those of the first by having the whole of the wings tinged with yellow-fulvous, so that the dark pattern is brownish and the light spaces yellowish." This leaves it an open question whether the yellow-fulvous tinge is on the upper or undersides of the wings, or on both. I have concluded, from the examination of a series of specimens of both broods from Central Italy, that it refers

to the underside, and a remark (in litt.) by Querci, who has collected much of the material used by Verity, seems to settle the question. He writes, "underside pattern of the second brood a little more fulvous than in the first brood." This coloration of the underside is, however, by no means constant in the second brood in Europe; but Powell notes that in N. Africa the summer brood has the underside of the hind-wings of a reddish-buff colour. This variety, in Europe, is therefore only a race in the strict sense of that term, and not a true seasonal form as in Africa.

race **quercii,** Obth.

This is a large race, occurring between 2000 and 3000 ft. in the Aurunci Mountains, the Lessini Mts. and in the Camerino Mts. In addition to its considerable size (32–34 mm.) the white markings of the hind-wings are as distinct as those of the fore-wings, and much more extended than in the type, on both upper and undersides.

Among the minor variations, single specimens which make some approach to *quercii* are not very unusual. In such aberrations the median band on the upperside is fully developed, and more or less free of dark scaling. There is, however, no increase in size of the band, and the other markings remain normal.

ab. **albovelata,** Vty.

Another variation of the upperside, which is densely scaled with white.

On the underside of the hind-wings the extent to which the spots between nervures 2 and 4 are suffused is a variable feature; they are often quite clear, often the apparent break is very pronounced, much more rarely there is a real break, the spots being divided by a ring of the ground-colour. Of further variation of the median band we have :

ab. **pallidissima,** Vty.

Unusually large specimens (34 mm. and over), with paler coloration of the underside. This aberration is not rare in Central Spain, being most frequent among the ♀s. It occurs throughout Spain, and more rarely in France, too.

ab. **reducta,** Warr. (Pl. XXVII, fig. 5.)

Specimens with a straight inner edge to the central spot of the median band, underside.

This aberration is of frequent occurrence and marked appearance. The likeness to *armoricanus* which extreme specimens present has already been mentioned. It is not restricted to either sex, but is perhaps of more frequent occurrence in the ♂s.

The basal spots are another feature of the underside which varies greatly; a glance at the six photographs of the underside on Plate XXVII will show the formation of these spots to be different in each one, especially spot 3, which is frequently of different shape on the two wings of one insect.

ab. (? race) **conyzae,** Guenée.

This is an aberration in which the ground-colour of the underside of the hind-wings is of a greyish tone. It occurs not uncommonly everywhere that *onopordi* is found. There is a considerable variety in the shade of the underside, and it seems very unnecessary to have named this aberration, as it is absolutely impossible to say which of the many shades of colour prevailing should be referred to it. Also the colour is altered by exposure to weather, and worn specimens are often very pale when compared with fresh ones. Verity accepts *conyzae* as an alpine race, on the strength of Oberthür's figure

of a specimen from Zermatt. This is an entirely mistaken view, for apart from the uncertainty which remains as to the Zermatt record, which will be referred to later, we find no sign whatever of any alteration of colour in the specimens from other high-level localities, and the locality from which the type specimens of *conyzae* came (not far from Geneva) was not an alpine one. Unfortunately, although repeatedly looked for, it has never been taken again in that particular locality; but our knowledge of the species does not lead one to expect that the pallid coloration would be anything but aberrational, even there. Whatever *conyzae* may prove to be in the future, if it should ever be discovered in the type locality again, at any rate it will not be an exclusively alpine race.

Date of Emergence and Duration of Flight Period.—The species is double-brooded in most low-lying European localities, with a moderately extended flight period; also the emergence of the first brood varies greatly according to the locality, and these two facts have given rise to the suggestions that it has three or even four broods. So far, sufficient data to confirm these theories are not forthcoming. In the lowlands of Switzerland and France the first brood extends from early April to late May, or early May to mid-June; and the second from early July to late August, or mid-July to mid-September. In the Rhone Valley, in a normal year, the first brood appears about April 10th and lasts to about May 20th; and the second from July 18th to mid-September, leaving a break of practically two months between the broods. In abnormal years, these dates can be altered by weeks, the second brood appearing in late June and disappearing proportionately earlier. In the south of France and Italy and Spain the first brood seems seldom to be seen before the middle of May; records of even late April being rare, which seems to be the reverse of what one would expect, but all available data corroborate the fact. A few actual dates are: Albarracin May 25th–June 11th; Ronda April 19th; Hyères May 13th (Sheldon); Bordighera May 13th; Rapallo June 5th; Septîmes May 9th (Reverdin); Digne June; Brides-les-Bains June 9th; Cannes April; St. Maxime April 20th; Draguignan May 2nd–6th (Chapman); Florence May 7th–June 15th (Querci), etc. One can only suppose that the great heat and consequent burnt state of the vegetation in these localities prevents the larva from feeding to any extent in the autumn, thus keeping it back in the spring. Querci (in litt.) bases his suggestion of four broods on the following data: the capture of first-brood specimens in early June, others from July 10th–18th, more from August 10th–24th, and late September records from other localities. From my knowledge of the habits of many species of *Hesperia*, I feel convinced that it is not possible for a brood to emerge and exhaust itself, and completely disappear, in eight days, and that Querci's July specimens were, in all probability, an advance guard of the same brood as the August specimens. The second brood, emerging from July 10th, would easily last to late August or even early September, renewing itself occasionally throughout the first four weeks. Late September specimens are no unusual occurrence if the second brood has not begun to emerge before late July. Querci's records for the flight period of the species in the neighbourhood of Florence seem more normal, *i.e.* May 13th–June 15th, 1917, and August 7th–September 29th, 1917; though he still speaks of the late September individuals as fourth brood. The occurrence of July specimens at Florence some other year would be nothing unnatural, nor any proof of an intermediate brood between June and August, in fact I should expect the second brood to appear in late July,

as it does in most other localities, including many parts of Central Italy (*i.e.* Villalago July 15th; Subiaco July 28th; Assisi July 29th, Wheeler). We find further corroboration of this in some data Reverdin obtained from France. Most records available, being for single dates in different years, are but of little use; Reverdin's dates of the occurrence of the species in Septîmes are: May 9th–June 13th, 1915, and July 11th–September 12th, 1915.

There is evidently much less interval between the two broods in southern localities than there is in Switzerland, probably only some five weeks. It is, however, not at all as simple a matter as might be supposed to determine accurately the exact duration of this interval. To suppose that a brood is over, because for a few days no specimen has been seen, especially if large numbers of it have been captured, is a very risky supposition.

Powell has established the fact that in North Africa the species has three distinct broods; his notes on the subject are as follows :—

"In the Aurès region (Dept. Constantine), where I studied it (*onopordi*) rather closely, it has three broods, which overlap more or less. Specimens were taken by a native collector from April 10th to the end of that month, 1914. I found the first brood myself, at Lambèse (1912 and 1913) flying in May, specimens still occurring during the first fortnight in June. Towards the end of June, second-brood specimens began to appear, and I was taking specimens characteristic of the second brood throughout July and August. Another brood appeared early in September, and went on until early October. The summer brood has the underside of the hind-wings of a reddish-buff colour, the spring and late summer–autumn broods have the underside of the hind-wings olive-grey or grey. The second brood was abundant at Sebdou (Dept. Oran) in July 1907, mainly in rather damp situations, edges of marshy meadows and along the banks of 'seguias' (small irrigation canals).

"*Onopordi* was common in the Azrou district (Morocco) in June 1920 and 1921. I observed considerable numbers in a clearing of the forest of Azrou, July 11th and 12th, 1920, settling in clusters on a damp spot near a well, together with *H. numida.* It was not uncommon on the shores of a little lake near Timhadit, August 11th, the ♀s observed to be ovipositing on a small *Potentilla.* It was flying on the banks of a small stream at Ben Smime near Azrou on October 11th, 1920. It was fairly common at Daiet Achlef (1700 metres) between June 20th and 30th, 1923; this was no doubt the first brood. I found it at Itzer in mid-August 1923, along the green edges of seguias and in marshy valleys. Fairly common at Bekrit in June and July 1924, also at Aguelmame Sidi Ali (2100 metres) end of July."

He further supports these data by numerous notes on his efforts to breed the species. He notes :—

"At Lambèse I found many ♂s already rather worn, but the ♀s were fresh, May 8th, 1912; I watched one lay an egg on a leaf of *Malope malachoides* and discovered one very young larva on the same plant. This larva pupated July 10th and the imago emerged July 20th. Between July 22nd and 26th, 1913, at Lambèse, eggs were laid by four captive ♀s of the second brood. They hatched between July 27th and 31st. Some of the resulting larvae had reached the 6th (last) stage by the end of August; others were then in the 5th stage, and one only in the 4th. From ova laid by a ♀ at Lambèse in October 1912, I obtained larvae which lived through the winter out of doors, at Hyères. The egg stage in the autumn lasts three or four weeks. The larvae were very sluggish throughout the cold period, feeding only during warmer spells. They became more active in February, then being in the

third stage. . . . The survivors pupated in May, and two imagines were produced on the 13th and 14th of June, respectively."

These notes show clearly that a third brood exists in North Africa, and that from eggs laid in late July the perfect insect can emerge by September 10th. They also show, however, that the length of time required to develop the second (summer) brood, from eggs laid on May 8th, is a little over 10 weeks, *i.e.* as long as is the case in the Rhone Valley; but that the lapse of time between the summer and autumn broods is shorter, only just over six weeks. It is possible, then, that there is a partial third brood in Italy, especially in seasons when the second brood appears early in July. There is no question, however, that there cannot be four broods, nor must we accept every September specimen as a proof of a third brood; for we know that September specimens often occur in localities in Switzerland and France where there are certainly only two broods. In view of these facts, if we maintain the species to have three broods in any given locality, we must be able to show that a fair number of specimens can be found on the wing in that locality in late September and early October, which is certainly a very rare occurrence in Europe.

In the mountains, or rather in subalpine regions, the species is single-brooded. In such localities it emerges in July, and seems to be found all through August. Quite likely, if looked for, it might be found in early September too.

Distribution.—*Onopordi* is essentially a southern species, apparently reaching its most northerly limits in Switzerland and Italy. Its eastern boundary is quite uncertain, Kronstadt (Rumania) is the most easterly locality from which I have seen specimens. It is habitually found at low elevations, but now and again seems to ascend into subalpine regions. The records from the latter are few, and further data on the question are badly wanted. There are only four records of its occurrence at an altitude of over 5000 ft. One at Imentalla, Atlas Mountains (5500 ft.), a specimen in the British Museum collection taken by Meade Waldo; two from Morocco by Powell, at Daiet Achlef (5500 ft.) and Sidi Ali (6800 ft.); and one European record by Oberthür, Zermatt (5300 ft). About the three African records there can be no doubt; but as to the Zermatt record, there are certain possibilities which make one pause before quite accepting it. The specimen figured by Oberthür is unquestionably *onopordi,* even though it is of a somewhat unusual colour; but even with the most careful worker slips will occur, and the papers on the Hesperids in Oberthür's great work are no exception to this rule; so that in want of any further captures of *onopordi* at Zermatt one cannot but ask if some mistake occurred as to the locality from which the specimen came. Were Oberthür's specimens possibly taken a little further down the Nikolaital, or even in the Visptal? This possibility is supported by the knowledge that *onopordi* occurs at the entrance of most of the lateral valleys on the south side of the Rhone Valley, and some way up them; and that so far it has not been found above 3600 ft. elsewhere in Switzerland.* I have personally devoted much time to looking for *onopordi* in every alpine locality in which I have collected (including Zermatt), without success. Of course, in France, it occurs in many places between 2000 and 3000 ft., and in one locality at not much short of 5000 ft., so that one is far from saying it is impossible for *onopordi* to occur at Zermatt; still, until some further specimens are taken in that locality, one cannot accept for certain that *onopordi* exists above 5000 ft. in Switzerland. Some high-level localities are: Bourg St. Maurice, 2600 ft.,

* See Note (2), p. 161.

Pre St. Didier, 3250 ft.; Allos, 4670 ft. (Chapman) (the latter being, by a thousand feet, the highest European locality at present known, apart from the Zermatt possibility); Spondinig on the Stelvio Pass, 2880 ft. (Chapman); between Brig and the second Refuge on the Simplon Pass, to not more than 3600 ft. (Warren).

European localities:—

France.—Septîmes; Le Contronne; St. Baume; Plan d'Aups; Mt. Ventoux (Reverdin); Digne (Reverdin, Chapman, etc.); St. Maxime; Cannes; Brides-les-Bains; Bourg St. Maurice; Bobbie; Draguignan; Allos; Celles; Nimes (Chapman); Vernet-les-Bains (Gibbs, Chapman); Hyères (Sheldon); Aix, Province (Wheeler).

Corsica: (Chapman coll.). [Wants confirmation: Powell has failed to find the species in Corsica.]

Italy.—Rapallo; Antignano; Bordighera (Reverdin); Brunate, Como; Pizzo Calvo; Mt. Gibbio; Pertusola; Vallombrosa; Casciana; Florence; Sibillini Mts.; Gran Sasso; Albano; Mte. Gennaro; Mte. Meta (Verity); Villalago; Subiaco; Assisi; near Fiesole (Wheeler); Alassio (Warren); Aosta; Neu Spondinig; Pre St. Didier (Chapman).

Sardinia: (Verity). [Wants confirmation.]

Jugoslavia.—Bosnia: (Chapman coll.).

Rumania.—Kronstadt (Tring Museum coll.).

Spain.—Sierra de Alfacar (Reverdin, Tring Museum coll.); Andalusia (British Museum coll.); Navalperal; Avila; Cuenca; Tragacete (Chapman); Ronda; Albarracin (Sheldon); Guardiola-Bagá; La Atmetlla (Sagarra).

Switzerland.—Pfyn Wald (Reverdin, Wheeler); Locarno (Chapman); Branson; Follaterre (Wheeler, Warren); Brig to 3600 ft. on Simplon Pass (Warren); (Zermatt?, Oberthür); Sion; Moûtiers en Tarentaise; Brides (Reverdin).

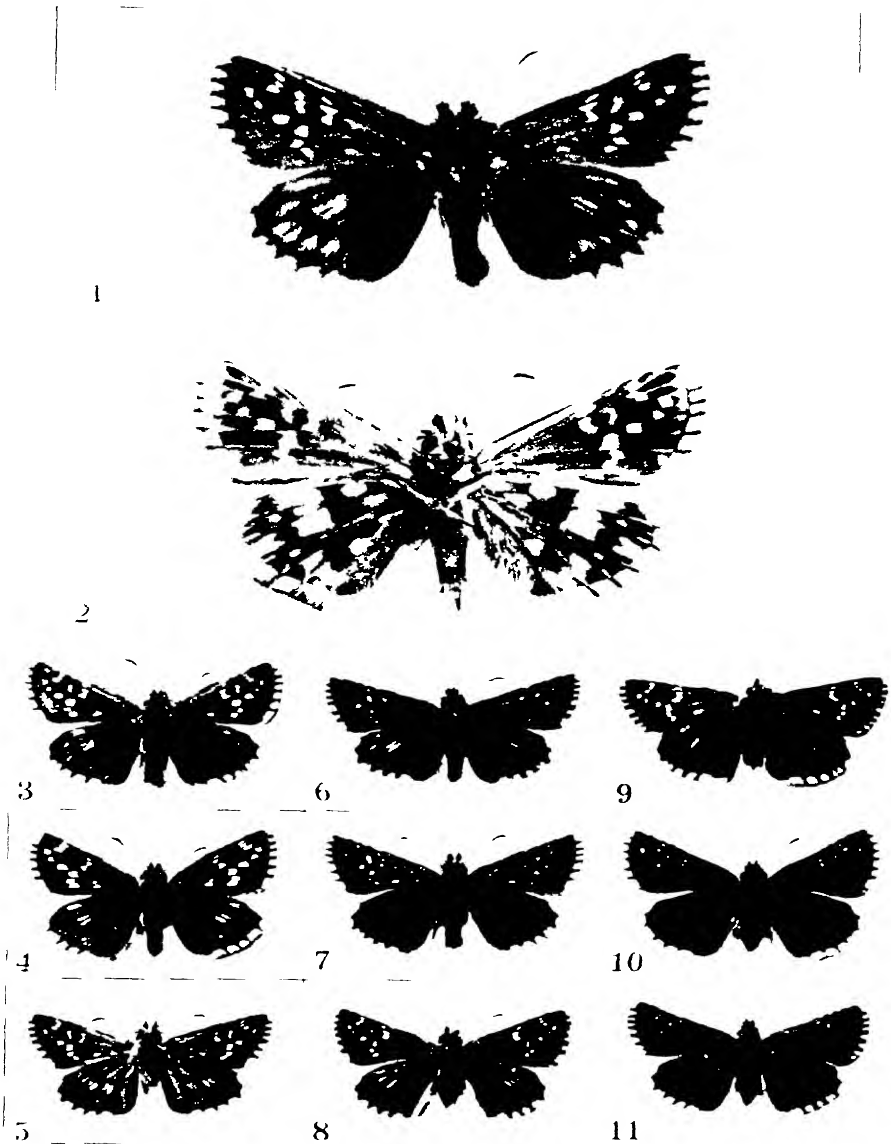
II. SERRATULAE Group.

Structural Characteristics.—Tenth sternite in ♂ incomplete; lateral apophyses highly specialised, short, and bearing numerous short spines; cuiller large and broad, proximal edge practically straight, uniting with the stylifer at half its length; style slender, long and more or less curved; ventral line of clasp flat.

Characteristic Facies.—Underside hind-wings: 3rd basal spot more or less rounded; central spot of median band with a straight inner edge.

Hesperia serratulae, Rambur. (Pls. XXVIII, XXIX and XXX.)

Identification.—*Genitalia.* (Pl. XXV, fig. 3.) The most striking feature in the ♂ armature of *serratulae* is undoubtedly the formation of the lateral apophyses. These are very broad, and their extremities somewhat rounded and covered with longish strong spines. Their great size is in itself sufficient to distinguish the species from the two other species of the group. The uncus is long and bends downwards at about half its length, where it is also considerably swollen, and then tapers rapidly towards its extremity. The clasp is very uniform in the species of this group, but develops all the same several pronounced individual characteristics. In *serratulae* the style is very long, broad at its base, but restricted almost at once (at the point where it bends over), and extends to the end of the clasp, tapering gradually to the tip, which bends down over the cuiller. The antistyle, broad, almost square, terminating in a straight line at its full width. The cuiller rises well above the dorsal edge of the harpe, and its apex is broad and gently rounded. Ventral plate narrow, its dorsal edge slightly concave about the middle, or nearer the distal end; subharpal plate short, the distance which separates it from the stylifer being practically twice as great as that which separates it from the ventral plate.



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Photos J C S Warren

Hesperia serratulæ

1 Upperside × 2 2 Underside × 2

Natural size

3 ♂ Lenzerheide (Grisons)
4 ♂ I clepens (Vaud)
5 ♂ Porto de Pajares
6 ♂ (ab) Lenzerheide (Grisons)
7 ♂ " "
8 ♀ Gavarnie
9 ♀ Tragacete
10 ♀ ab *cæcus* Pontresina
11 ♀ " Lenzerheide (Grisons)

The main points of difference in the armature which distinguish *serratulae* from the other species of the group are: the expansion of the uncus; the broad lateral apophyses, which Reverdin noted as being in appearance suggestive of a hedgehog; the long style and broad antistyle; the height of the cuiller and its broad apex, and the short subharpal plate.

General features.—In size a very variable species, occasional minute specimens occur of only 22 mm., the opposite extreme being examples from the Vienna district which attain a size of 36 mm. Large size seems to be a feature of specimens from many eastern localities, but the extreme west of France produces a race which is larger than any other, falling but little short of the largest Eastern aberrations. On the average the normal size of central and southern European specimens seems to be 28–30 mm. *Upperside*:—Fore-wings: discoidal series incomplete, variable, usually only the 1st and 4th spots present; median row complete, composed of well-developed spots of fairly regular formation, 4th and 6th situated in close proximity to the 3rd and 7th respectively; outer row wanting; discal spot present; subcostal spots reduced to one, situated immediately over the discoidal lunule. Hind-wings: basal spots wanting; median band faintly indicated; marginal row also faint. *Underside*:—Fore-wings: discoidal series incomplete, discoidal lunule alone present; median row complete; discal spot strong, but not sharply outlined; subcostal spot faint, but distinct from surrounding suffusion. Hind-wings: basal spots present, clearly separated from each other by the ground-colour, the 3rd which is the largest and most sharply defined, has both its ends rounded; median band complete or incomplete, central spot with straight inner edge, 1st spot distinct, not blending with the ground-colour of the inner margin; marginal row variable, consisting of a series of four or five more or less disconnected spots, usually united to the margin of the wing. Ground-colour, yellowish-orange varying to greenish-yellow, of very uniform density all over the wing; inner marginal area darkish-grey. Nervures scarcely visible, except between the white spots, where they are strongly marked in the same shade as the ground-colour.

Comparison with the other Species of the Group.—*Serratulae*, on the whole, is not difficult to distinguish from those species most nearly related to it, on account of the yellowish tone of the ground-colour of the underside of the hind-wings; this, in both *carlinae* and *fritillum*, is of a warm reddish tone. The date of capture, if specimens have been accurately labelled, should be sufficient to prevent confusion arising between *serratulae* and *fritillum*; for the former flies in the spring and early summer, and the latter in the late summer and autumn. But, even with unlabelled specimens, the form of the discoidal lunule in *serratulae*, its very irregular width and jagged edges, and the faint white markings on the upperside of the hind-wings (often almost invisible), should enable any specimen to be distinguished from *fritillum*, even if the latter be of the form of variety in which the ground-colour of the underside of the hind-wings is more yellow than red. With *carlinae*, however, there may be a little more difficulty; both it and *serratulae* often fly together. Even so, the condition of the specimen should be a guide, as *serratulae* is always out some weeks earlier than *carlinae*. The colour of the underside of the hind-wings is undoubtedly the readiest means of identifying the two species, for though *carlinae* varies a good deal in this particular, it practically never produces a colour similar to *serratulae*. Other points in which *serratulae* differs from *carlinae* are: the comparative invisibility of the nervures on the underside of the hind-wings, excepting where they pass between the white spots; and the even density of the ground-colour, which is decidedly uneven in *carlinae*, some parts being much darker than others, giving the whole a more mottled appearance that is never seen in *serratulae*. Then

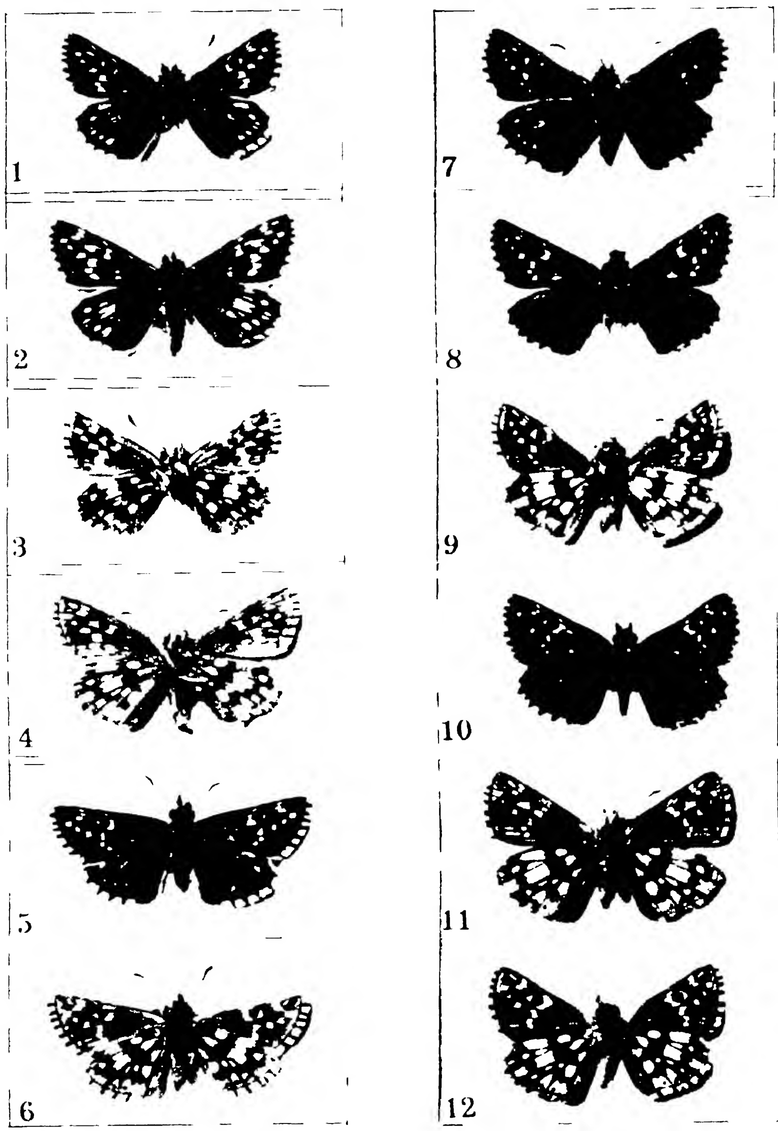
also, in *serratulae*, the spot between nervures 4 and 6 on the outer margin of the hind-wing underside is about as broad as it is long, very different from its long narrow formation in *carlinae*; and the 3rd basal spot is always more or less oval in *serratulae*, and much rounder (on occasions even square) in *carlinae*. These points should always be sufficient to permit of the identification of any specimen. The character of the nervures is much more pronounced than photographs would lead one to suppose. Photographs exaggerate their prominence in *serratulae*, owing to their being slightly raised and in consequence taking the light more than their surroundings. The natural-sized photographs give the truest impression. In *carlinae* the nervures are outlined in a lighter and brighter colour, and catch the eye immediately; in *serratulae* they require looking for.

Comparison with other Approximating Species of the Genus.—From the typical forms of the other Hesperias *serratulae* is easily distinguished. From *alveus* and its allies the markings of the underside of the hind-wings in general, their finer and less heavy nature, and the form of the 3rd basal spot, will readily keep *serratulae* apart; and from the species of the subgenera *Teleomorpha* and *Hemiteleomorpha*, the very straight inner edge of the central spot of the median band will be sufficient; but with aberrations where this spot is not rectilinear there will be more difficulty. This will, however, only be in connection with small specimens of *carthami*, for all the other species are so characteristically marked that *serratulae* could never be mistaken for them. As the likeness to small *carthami* has been already dealt with in connection with the latter, it is only necessary to mention here, as shortly as possible, the points which distinguish *serratulae*.

On the upperside *serratulae* is more or less uniformly dark, never with much pale scaling; spot 5 of the median row is very much smaller than the others, rarely full-sized. Underside hind-wings: the spot of the marginal row between nervures 4 and 6 is often forked at its tip, or inner edge; but occasionally not, when it has a flat inner edge; when forked, the ends are square or rounded (the inner edge of this spot in *carthami* normally forms two sharp points); the ground-colour very uniform, never mottled; the inner margin of the wing, dark grey, the 1st spot of the median band inclined to have a roundish appearance and quite distinct from the margin.

Certain aberrations of *serratulae* take a rather *alveus*-like look, especially those in which the 3rd basal spot has become more or less square. Some of these, principally ♀s, are often difficult to identify, but with care it is quite possible to do so.

On the underside of the hind-wings in *serratulae* the ground-colour is of absolutely even density, not showing any darker or lighter areas, and the nervures are practically invisible against the ground-colour, but when they pass through, or by, any of the white markings, they show very strongly, as lines of ground-colour, separating all the white markings into spots. This is especially pronounced where they cross the median band and between the basal spots. It is very rare, in *serratulae*, to find the median band between nervures 4 and 8 forming a band-like whole; it is practically always composed of three distinct spots which do not extend on to the nervures. In *alveus* and its allies the nervures are plainly visible against the ground-colour, and where they cross the median band they are usually covered by the white of that band, and to the eye are obviously, even when not white, just nervures crossing a completed band and not, as in *serratulae*, divisions of ground-colour between



J Bale, S. & D, Ltd *Photos B C S. Warren*

Hesperia serratula

Natural size

1—4 ♂ s sp ***uralensis*** Uralsk
5 and 6 ♀ ,, ,, ,,
7 9 ♂ ,, ***balcanica*** Cetinje Montenegro
10 12 ♀ ,, ,, ,, ,,

distinct spots. Further, in *serratulae*, these divisions are the same colour as the rest of the ground-colour, and not lighter, as so often is the case in the other species. The resulting effect strikes the eye, more readily than any description would lead one to suppose, as a design of isolated spots rather than a series of bands; and in the former it is remarkable that the larger the white spots become, the more definitely they stand out as such, while in the latter any increase in size also further increases the appearance of continuity in the band-like markings. Of course, aberrant specimens of *serratulae* exist in which the median band is united between nervures 4 and 8. I have such specimens from Spain, the Pyrenees and the high Alps, but, in these aberrations, the other features mentioned are quite normal, and so the specimens can be identified without difficulty.

On the upperside, the discoidal lunule is large and concave on the outer side in *serratulae*, usually to a decidedly greater extent than is normal in *alveus* and its allies; in the latter it is also very frequently narrower than in *serratulae*.

Sexual Dimorphism.—On the average the ♂ has more pronounced spotting on the upperside of the fore-wings than the ♀; what would be considered a very strongly marked specimen for a ♀, would have scarcely as pronounced spots as the average ♂. The ground-colour of the upperside in the ♂ is black, that of the ♀ more brown; the former occasionally has a very slight amount of grey superscaling on the basal area of the wings, while the ♀ usually has a considerable quantity of golden scaling, sometimes with a greenish tinge in it, which occasionally covers the whole of the fore-wings and certain areas of the hind. The ♂ has a costal fold on the fore-wings.

Variation.—The variation of *serratulae* is of some interest, but there is little doubt that a better supply of specimens from the less well-known countries would greatly add to that interest. *Serratulae* is a species with a very great range in Europe and Asia, and, as is frequent in such cases, shows a marked tendency to develop local forms; so far, however, owing to insufficient material, it is difficult to estimate the true standing of some of these forms. The only European subspecies which has as yet been named, is:

s.-sp. **occidentalis**, Lucas. (Pl. XXX, figs. 9–12.)

A magnificent race of great size, 34 mm.; with all the white markings finely developed in proportion to the increase in size. Found in the Forêt de Vouvans (Vendée).

There seems not much doubt that this fine race replaces the type in the Forêt de Vouvans. The only difference between it and the type is of course its great size, and the proportional increase in size of all the markings. It is interesting to note, however, that, in spite of the latter, spot 5 of the median row still remains extremely small. Ordinary aberrations of the type in this direction (increase in size of markings) have this 5th spot also enlarged to some extent, as can be seen in fig. 4, Pl. XXVIII. This shows the development of the markings in *occidentalis* is not in any way abnormal—as it is in the aberration just mentioned—but just the proportional increase corresponding to the increase in size of the insect.

s.-sp. **balcanica**, nov. (? race). (Pl. XXIX, figs. 7–12.)

Large, 32–34 mm. Wings broad; upperside fore-wing white markings much reduced in ♂s, some spots almost obsolete in ♀s; spots of median row arranged as in *alveus*, i.e. 4 and 6 well separated from 3 and 7 respectively. Hind-wings very dark; but one specimen shows the normal amount of obscured

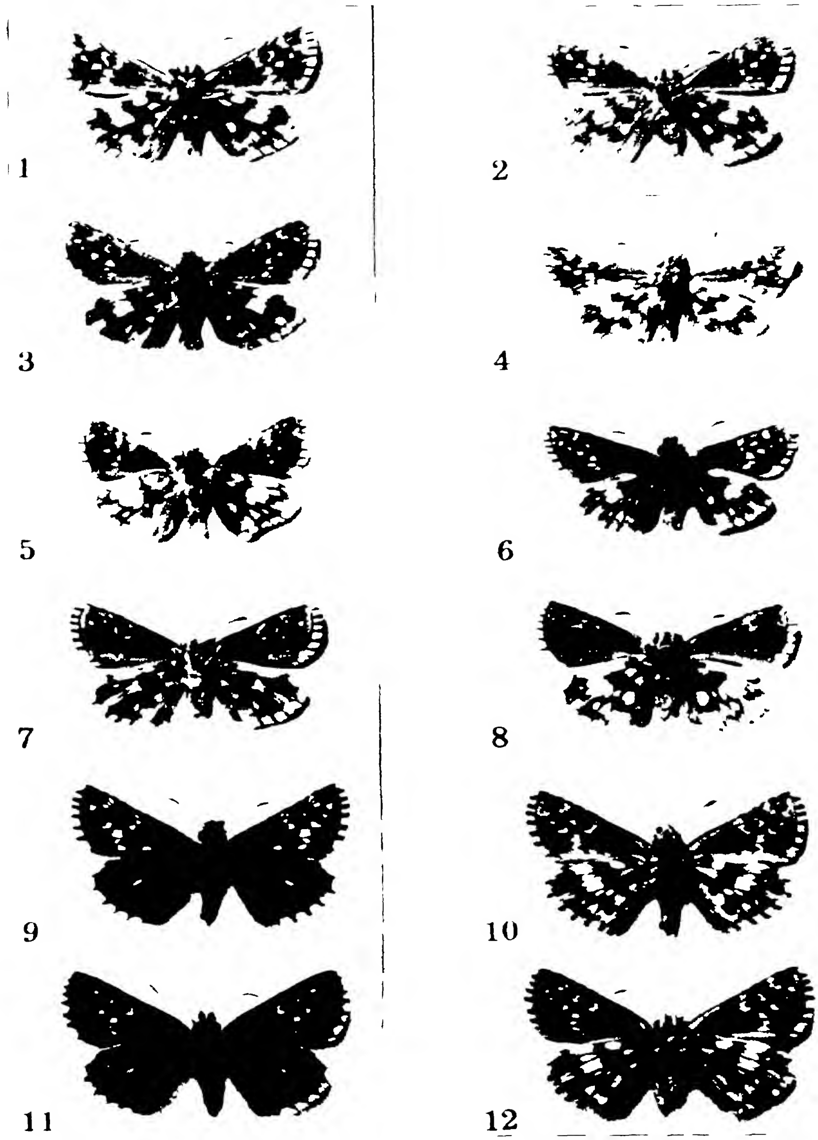
white typical of *serratulae*. Underside: fore-wings with spots larger than on upperside, practically typical; hind-wings with all white markings, basal spots, median band and marginal row very large. Nervures broadly marked with ground-colour where they cross the median band, breaking it into spots much more markedly than usual. Described from five specimens, 2 ♂s and 3 ♀s, taken in Montenegro in the neighbourhood of Cetinje, by the late A. E. Gibbs.

As will be seen in the photographs, this subspecies shows remarkable features. The reduction of white on the upperside, accompanied by the great increase of white on the underside, is very unusual; also, in all other large forms of the species, there is at least the normal amount of white on the upperside of the fore-wings, if not more. Although smaller on the whole than the s.-sp. *occidentalis*, the markings of the underside of the hind-wings are pronouncedly larger, the great breadth of the median band being especially noticeable.

In one of the ♂ specimens the fore-wings are not quite as broad as in the other ♂ and three ♀s. The presence of this one specimen, added to the fact that I only possess five altogether, leaves an element of doubt as to whether this remarkable form is a true subspecies or only a race. Its facies are, however, so specialised, and in four of the specimens quite constant, and the 5th, though varying a little as to the breadth of the wings, is otherwise essentially connected to the four rather than to typical *serratulae*, that it seems most probable this race is the normal one of the district. As it is, however, the point must remain uncertain until further specimens are available.

s.-sp. **uralensis**, nov. (? race). (Pl. XXIX, figs. 1–6.)

Of average size, 30 mm. Upperside: ground-colour of ♂s as well as ♀s brownish-black; all white markings of ♂s large and distinct, including the median band and marginal row of the hind-wings. In the ♀s, these markings are not as much developed as in the ♂s, but for a ♀ they are very strong on the fore-wings, and a little more than is usual on the hind-wings. Underside: white markings all as pronounced as on the upperside, the marginal row usually strongly developed. Ground-colour of fore-wings suffused with grey on the basal half, and at the apex. Hind-wings of the greenish tone that is often seen in alpine specimens. Described from three specimens, 2 ♂s and 1 ♀, taken between the 3rd and 10th of June, 1907, in the neighbourhood of Uralsk by Max Bartel. This subspecies, as will be seen in the photographs, shows far more white on the upperside than any other known form of the species. The heavy square spots on the fore-wings far exceed the normal proportions of these spots even in the s.-sp. *occidentalis*, although the specimens are only of average size; and in the ♀, though the median row is smaller than in the ♂, when compared with a type ♀, even a strongly marked one such as fig. 9, Pl. XXVIII, they are seen to be of a heavier character. The markings on the upperside of the hind-wings are still more unusual. At the first glance it is difficult to believe that the ♂s really are *serratulae*, and the size of the spots of the marginal row on the underside is almost equal to those markings in *balcanica*. There are several points of similarity between this subspecies and Staudinger's *alveoides*, which Mabille notes as being smaller than true *serratulae*, with the ground-colour of the upperside ashy grey, having the white spots of the fore-wings larger, and a median row visible on the hind-wings; the underside paler. He adds, "appears to be a second brood in Syria." *Uralensis* differs from this in being full average size, with a brown ground-colour on the upperside, the hind-wings having a very pronounced marginal row of spots as well as the median band, and the specimens, as noted,



J. Bale S. & D. Ltd. Photos E. C. S. Warren

Hesperia serratula

Natural size

1 Eclepens (Vaud)
2 typical Bergün Albula Pass
3 (ab.) Pontresina
4 (ab.) *extensa* Kandersteg
5 (ab.) Ofen Pass
6 (ab.) Kandersteg
7 (ab.) Upper Engadine
8 (ab.) Pontresina
9 and 10 ssp. *occidentalis* Forêt de Vouvans (Vendée)
11 and 12

were taken in June. The reference to the second brood makes one wonder if Staudinger's insect is a form of *serratulae* at all.

As in the case of *balcanica*, it is greatly to be regretted that we have so few specimens; so the question as to whether *uralensis* is a true subspecies or not has to remain open; though the very remarkable characteristics occurring in both sexes strongly suggest that it is a more constant form than a mere race. It may be said that the describing of this subspecies is going outside the limits of this monograph, but though Uralsk is just outside the limits of political Europe, the fauna of the region on the western side of the Ural river is purely that of eastern Russia, and is in no way disconnected from the latter, and almost certainly the species found in either area are common to both, the fauna of eastern Russia probably extending all over the region west of the Mugojar Hills.

Before passing to the aberrational forms one must mention the supposed "alpine" and "lowland" races of the species. These terms, apart from designating the origin of certain specimens, have no meaning, for *serratulae* does not develop any true racial facies constant to either high or low levels. It is therefore misleading to apply names as Verity has done (*Ent. Record*, vol. xxxvii, p. 57) to races suggested to be the prevailing forms at higher or lower levels. The characters he gives are only those covering the ordinary range of variation of the species at any altitude. Of his two races, one (*latealbata*) is indistinguishable from typical *serratulae*; the second may be noted as a race, but without any claim to restriction to low levels, as he implied.

race **planorum,** Vty. (Pl. XXVIII, fig. 4, and Pl. XXX, fig. 1.)

Large size, about 30 mm., but often smaller; ground-colour underside hind-wing brighter than in the type, of varying shades of yellowish-orange. All white markings varying as in the type. The specimens figured show the extreme form. This race occurs with the type at all altitudes.

Verity's description was based on Reverdin's figure (*Bull. Soc. Lép. Genève*, vol. ii, pl. 4, fig. 13). Specimens as extreme, as regards colour, as that figure are more aberrational than racial, less pronounced forms are common. It must be remembered, however, that the type is just as abundant in the lowlands as *planorum*.

The minor varieties of *serratulae* are very numerous. On the upperside, the reduction or enlargement of the white spots gives one a completely graduated series of forms, from practical invisibility to a highly developed series of spots. Names have been given to extreme forms in both directions, but the intermediate forms are far the most usual.

ab. **tarasoides,** Höfner.

This aberration has the white spots on the upperside partly confluent. A rather rare aberration.

ab. **caecus,** Frey. (Pl. XXVIII, figs. 7, 10 and 11.)

The white spots on the upperside greatly reduced in number and size, even quite absent.

It seems probable that the extreme form of this aberration only occurs in the ♀. Fig. 7 shows what is a decidedly extreme form for the ♂; figs. 10 and 11 show two ♀s with considerably less spotting; such specimens are by no means rare.

ab. **conspersa,** Rev.

A rare aberration in which the first two spots of the median row are united, as are also the first two of the discoidal series, on the upperside, and in addition

the first spot of the median row is united with the first of the discoidal series.

ab. **ochracea,** Rev.

A remarkable and rare aberration in which both the upper- and under-sides are suffused with an ochreous shade, covering all the white markings, including the fringes. So far only three specimens are known, all coming from Tramelan, in the Jura.

On the underside of the hind-wings we find much variation in the white markings. Perhaps the most frequent form is that in which some of the spots are extended, and tend to unite with others. The 3rd basal and 6th spot of the median band are the most often affected. We illustrate four specimens of this form (Pl. XXX, figs. 5–8) showing four phases of confluent variation, from a slight extension of the 6th spot of the median band to complete union of that spot and the 3rd basal one.

ab. **extensa,** Warr. (Pl. XXX, fig. 4.)

Specimens in which the inner edge of the central spot of the median band, underside hind-wing, is not straight, but projects sharply towards the base of the wing.

The name was given to this form of aberration in all those species in which the inner edge of the central spot is normally straight. In *serratulae* it is by no means rare, and sometimes gives the specimen developing it a great look of *carthami.*

ab. **alveiformis,** nov.

The 3rd basal spot less elongated, and with straight ends, giving it an almost square appearance, also less pronouncedly separated from the 2nd spot, the 1st spot of the median band also squarer.

This aberration may be very similar to a small specimen of *alveus*, and if the affected specimen should be a ♀ and slightly larger than usual, there may be some difficulty in identifying it. As a rule, though, the other characteristics of the underside which have been described will remain sufficiently typical to decide the question.

The rarest form of underside variation is the reduction of the white markings. Any of the spots may on occasions be reduced a little, but apparently never more than one or two spots at the same time. A very unusual specimen is shown on Plate XXX, fig. 3, in which the 3rd basal spot is reduced to a mere point. It is very remarkable that this does not really alter the *serratulae*-like look of the specimen.*

Date of Emergence and Duration of Flight Period.—*Serratulae* is single-brooded; of this there can be no doubt, in spite of Staudinger's reference to a second brood in Syria. In the lowlands the species emerges early in May, and can be seen on the wing for perhaps a month. It seems to be more influenced by altitude than other species which occur in both lowland and alpine regions, a little rise retarding the emergence immediately to a considerable extent; so that at high levels, anything over 5000 ft., it is often found in August. This makes a curious contrast to the habits of *alveus*, for when the

* ab. *fragilis*, Vty. This name was given to *very small* specimens from the neighbourhood of Vienna (*Ent. Rec.* 1925, p. 57). They were described as having long and pointed, narrow wings, and being of a greyer tone of colour than is usual; also as being a "race" (*i.e.* subspecies). Such specimens, however, can be found with the type in most localities. The Vienna district is noted for the production of very large specimens. (See *ante*, under "General features.")

latter and *serratulae* both fly on the same ground in the lowlands, *serratulae* precedes *alveus* by a good two months; yet this great difference almost disappears about 4000 ft., where *serratulae* may be out a fortnight before *alveus*, but still can always be found flying with it. Still higher, about 6000 ft., as for instance on the Gemmi Pass, they appear almost on the same day. Latitude, on the other hand, does not seem to affect the species in the least, the earliest May records from the lowlands of Switzerland are not surpassed in the south of France. From Spain I have only been able to obtain a very few records, but they, so far as they go, bear this out. Any rise in altitude, however, even in Spain, at once brings the species into June and July; *e.g.* Albarracin, June 16th (Sheldon); Port de Pajares, July 15th; Tragacete, July 26th (Chapman). Once we start rising in the Alps we find *serratulae*, according to the altitude, from June onwards, at which date it is usually over below 1500 ft.; but there is no authentic record of its reappearance in the autumn, even at the lowest levels.

Distribution.—Very widely distributed in Europe and Asia. Mabille records it as found in Sweden, and there is a specimen in the British Museum collection from Lapland; but, apart from the latter, specimens from northern regions are entirely wanting, in all collections. Its southern range is also almost unknown. We have some records from Spain, and it seems certain that the species is much more widely distributed in that country than these few records would suggest. It is apparently wanting all along the French and Italian Riviera, and is scarce and local in Italy. It extends as far south as Montenegro in the Balkans. This is the very unsatisfactory result of all available records in connection with the southern distribution of the species. There cannot be much doubt that it is much more widely distributed in Italy and the Balkans than our records show, its range in Syria points to this. Eastwards it extends practically (? quite) to the shores of the Pacific Ocean.

European localities :—

Austria.—Grödner Joch; Gross Glockner; Kalksburg; Mardlinghof; Godello (Reverdin); St. Anton (Chapman); Stelzing (British Museum coll.); Vienna (Oberthür); Carinthia (Chapman coll.).

Belgium.—Virton; Wellin (Reverdin).

France.—Larche; Lac d'Allos; Mt. Genèvre; Lioran (Oberthür); Val d'Isère; Cauterets; Gabas; Fontainebleau (Chapman); Vernet-les-Bains (Gibbs); La Grave (Tring Museum coll.); Gavarnie (Warren); Digne; Luchon Hospice (British Museum coll.); St. Martin de Vésubie; Forêt de Vouvans (Reverdin, British Museum coll.); Samoussy (Wheeler); Abriès; Aix-les-Bains; Mt. Dore (Reverdin); Cantal (Lucas).

Germany.—Kreuznach (British Museum coll.); Kyffhaüser Gebirge (Reverdin). Widely distributed according to German authorities, but specimens from Germany are very rare in collections.

Hungary.—Budapest (Sheldon).

Italy.—Very local according to Italian authorities. Sibillini Mts. (Querci); Stelvio Pass; Duvontal (Reverdin); Mendel Pass (Chapman); Trafoi (British Museum coll.).

Jugoslavia.—Herzegovina: Maditsch Joch; St. Ulrich (Reverdin).
Montenegro: Cetinje (Gibbs).

Lapland.—Lapland (British Museum coll.). (Wants confirmation.)

Russia.—Majhop, Caucasus; Uralsk district (Chapman coll.).

Spain.—Sierra Nevada (Oberthür); Albarracin (Sheldon); Port de Pajares; Canales (Logrono); Tragacete (Chapman); San Ildefonso; Segovia (Tring Museum coll.); Santafé; Guardiola-Bagá; Vall de Nuria (Sagarra).

Switzerland.—Davos; Fusio (Chapman); Vallée de Joux (Gibbs); Bergün (British Museum coll., Warren); Elgg; Madris; Zermatt (Reverdin); Sierre; Sion; St. Georges; Steinental; Schafberg; Heutal; Palpuogna (Albula Pass); Celerina; Zinal (Wheeler); Bérisal (Wheeler, Sheldon); Kandersteg; Gemmi Pass; Champéry; Eclépens; Lenzerheide; Tschitta Pass; Pontresina; Roseg Tal; Preda; Zernez; Ofen Pass (Warren).

Hesperia carlinae, Rambur. (Pls. XXXIV and XXXV.)

IDENTIFICATION.—*Genitalia.* (Pls. XXXI, figs. 1 and 3; and XXXII.) In this species and the next—*fritillum*—there is a great similarity in the ♂ armature, and, up to the present, the character entirely relied on to distinguish between the two has been the formation of the lateral apophyses. In *carlinae* these are two slender and somewhat foot-like processes, armed at their extremities with spines of varying length. The excellent photographs on Plate XXXII show them very well. These structures are extremely variable; it is practically impossible to find two specimens in which they are absolutely identical; nevertheless, on the whole they maintain certain characteristics by which one probably could say that a given specimen was *carlinae*. On the other hand, occasional specimens do occur which are so close to *fritillum* that, had one no other data to rely on, the identity of the specimen must remain uncertain. Such a specimen is figured on Plate XXXII, figs. 3 and 4. These should be compared with the photographs on Plate XXXIII, which show the apophyses of two specimens of *fritillum*. It will be seen that, roughly speaking, the apophyses of *fritillum* are broader at their extremities, and the spines are of much more even length and more numerous. As in *carlinae*, however, the variation of these spines is limitless, and, as will be seen, in both species the number of spines and their shape is different on each apophysis. On Plate XXXIII, figs. 1 and 2 are from one specimen, and figs. 3 and 4 from another; likewise on Plate XXXII, figs. 3 and 4 are from one specimen; and figs. 1 and 2 each show the apophyses of one specimen, more or less in their natural position in fig. 2, and still attached to the main body in each case. It is no easy matter to mount these tiny structures so as to get them to the best advantage for photographing, so that the best result in many cases was obtained by detaching each apophysis from the main body and mounting it apart. Chapman, in his notes on these species, maintained that he had never found a specimen he could not identify by the apophyses, but I think he can hardly have been aware of the extent to which variation was possible. Fig. 4 on Plate XXXIII is far more typical of *carlinae* than *fritillum*, and though fig. 3, the right apophysis of the same insect, is more typical of *fritillum*, still with the knowledge that such specimens of *carlinae* as fig. 4, Pl. XXXII, do exist, I think it would be scarcely possible to feel quite certain as to the identity of the specimen; especially when one specimen can produce two such very dissimilar forms as figs. 3 and 4.

On Plate XXXII, figs. 1 and 2 may be said to be the typical form for *carlinae*, as figs. 1 and 2 on Plate XXXIII are for *fritillum*. In addition to the spines of the apophyses being of very unequal lengths in *carlinae*, they are, on the average, fewer in number than in *fritillum*. In *carlinae* they vary from 2 to 6 on any apophysis, normally 3 to 5. In *fritillum* 6 (? 5) is the fewest, and 9 the most, 7 to 9 being most usual. These figures are based on an examination of my own and a considerable number of Chapman's mounts of these species, about fifty examples in all. It would, then, apparently be safe to say that any specimen with 7 or more spines on either of the apophyses must be *fritillum*, and any specimen with 5 or less, *carlinae*. This would be all right so far as it goes, but it leaves the specimens with 6 in a doubtful position. In addition to the characters of the spines, Chapman noted the ventral margin of the apophyses as straight in *fritillum* and "without spines," and irregular in *carlinae* with a spine in the middle. He illustrates this in the *Entomologist's Record* for 1918, Pl. XI, fig. 6, showing a specimen of *carlinae* with a spine on the ventral margin. His reference to *fritillum* having the ventral margin "without spines" seems to suggest that he regarded the presence of this spine as typical of *carlinae*. This is quite a mistake; I have never seen an example of *carlinae* with the spine, except the one from which the photograph was taken; and as to the straightness of the margin in *fritillum* the photographs on Plate XXXIII show that the sole of the foot, if one may so describe it, can be just as

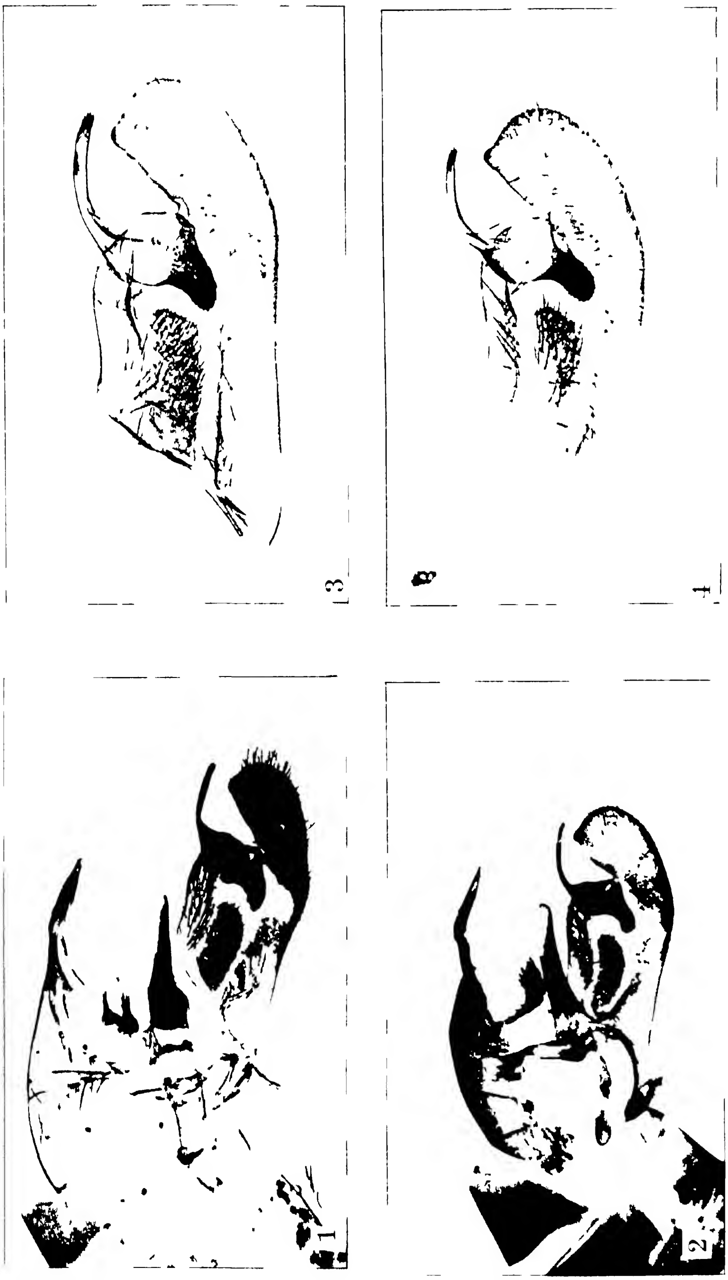


Photo 1 and 2 F Green, 3 and 4 A H Dennis

J Dale, S & D., Ltd

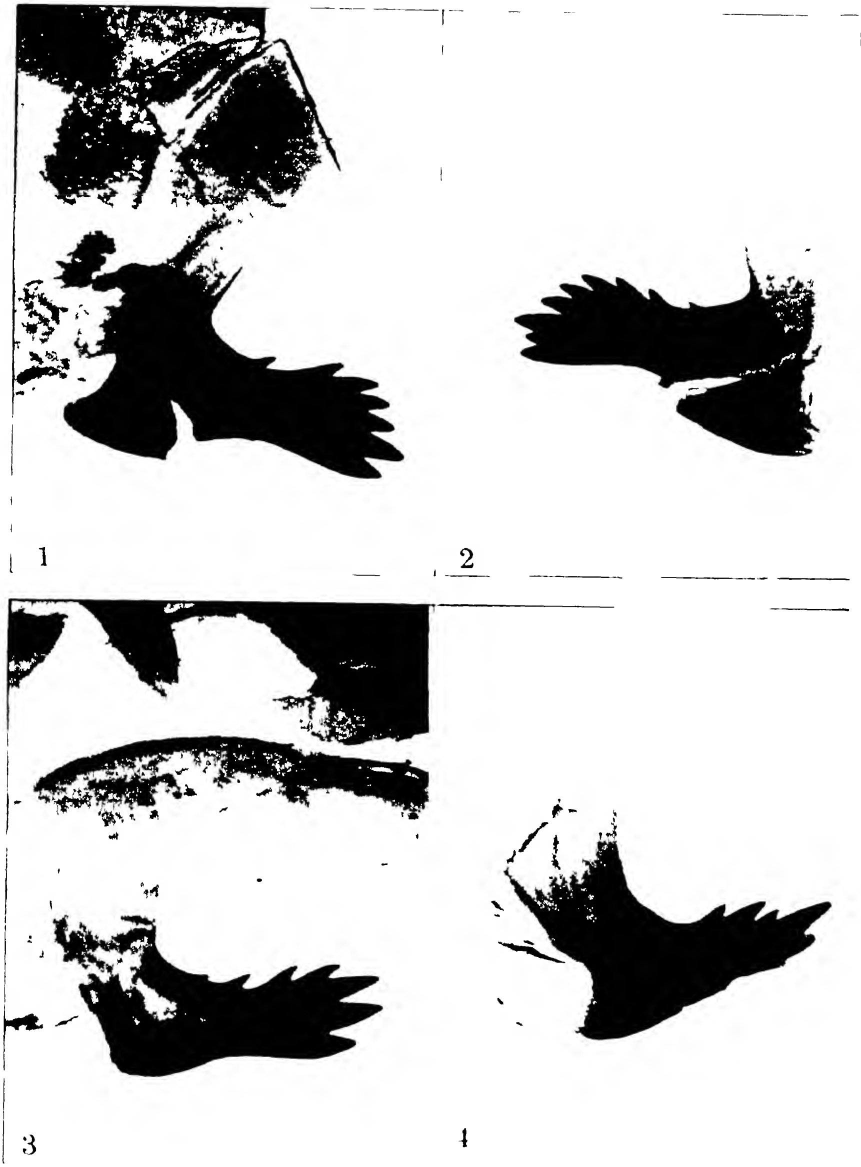
Genus *Hesperia* male armatures

1 *H carlinæ*
2 *H fritillum*
3 *H carlinæ*, right clasp × 25

J Bale S & D [illegible] *[illegible]*

Genus *Hesperia* male armatures

1–4 *H carlina* Lateral apophyses of the 10th sternite × 100



Genus *Hesperia*, male armatures.

1–4. *H. fritillum*. Lateral apophyses of the 10th sternite, × 100.

much curved in one species as the other. We must therefore, when comparing the lateral apophyses of these species, fix our attention on three characters, which compare as follows :—

Carlinae.	*Fritillum.*
I. The apophyses decrease in width towards their extremities, and terminate somewhat pointedly.	**I. The apophyses do not lessen in width at the extremities, and terminate more or less squarely.**
II. The spines are of unequal sizes.	**II. The spines are more uniform in size.**
III. Less than 6 spines.	III. More than 6 spines.

These characters will hold good in the majority of cases, but it remains a fact that occasionally they fail, especially in *carlinae.* I have dealt in detail with these processes, for up to the present it has been principally (if not entirely) on them that the claim to specific distinction of the two species has rested. Chapman noted in confirmation that the aedoeagus is wider in *carlinae,* and "there are other slight differences." The form of the aedoeagus is plainly to be seen in figs. 1 and 2 on Plate XXXI. What the slight differences were, I could not ascertain from any of his notes.

To turn to the clasps. Here we find a striking and constant difference between the two species, which would have settled the much-disputed question of their standing once and for all, had it not in some remarkable way escaped attention.

In *carlinae* the subharpal plate and harpe are united, and form one solid object; in *fritillum* the subharpal plate is situated centrally, and is as free from the harpe as it is from the ventral plate. On Plate XXXI, figs. 3 and 4 show the position of the subharpal plate in each with great distinctness, and this can also be seen in figs. 1 and 2.

There is no variation in this character. In *carlinae* there sometimes is a little thinning of the chitin at the point of union, but never the least trace of separation. In *fritillum* the subharpal plate is sometimes less widely separated from the harpe than it is in the specimens figured, but it is never united with the latter. The subharpal plate in both these species is of exceptional density, and practically as thick at its edges as centrally, and surrounded by absolutely unchitinised membrane (of course only on three sides in *carlinae*). The formation in *carlinae* is unique in the whole genus; in the subgenus *Hemiteleomorpha* we see the opposite, the subharpal plate and ventral plate uniting: and in the subgenus *Teleomorpha* the subharpal plate is occasionally united with the harpe, but in these cases it is of little density, especially towards the edges, which spread as much towards the ventral plate as towards the harpe. The other species of the subgenus *Ateleomorpha* all exhibit the same line of formation as *fritillum.* This leaves no room for doubt as to the specific standing of *carlinae* as quite distinct from *fritillum,* and the occasional failure of the lateral apophyses to keep distinct becomes a matter of little importance. There are slight differences in the form of the style and antistyle also, though both species show some variation in these points.

From *serratulae, carlinae* can be distinguished by the smaller cuiller, short style, narrow uncus, and the comparative smallness of the lateral apophyses; these points of course also distinguish *fritillum* from *serratulae.*

Before leaving the subject of the structural characteristics of *carlinae* and *fritillum,* it is interesting to note that the failure to recognise the elements of the primary semiclasp as something quite distinct from the secondary semiclasp, is unquestionably the cause which has led to the remarkable difference in the position of the subharpal plate in these species being so long overlooked.

General features.—Size, 30–32 mm., exceptionally 26–34 mm. *Upperside* :— Fore-wings : discoidal series incomplete, 3rd spot wanting; median row complete; outer row wanting; one subcostal spot present, situated immediately over the discoidal lunule; discal spot present, more or less indistinct. Hind-wings : basal

spots wanting; median band faintly visible; marginal row the same. *Underside*:—Fore-wings: discoidal series represented by the discoidal lunule; median row complete; discal spot present and clear. Hind-wings: basal spots present, 2nd the smallest; median band complete or incomplete, inner edge of central spot straight; marginal row incomplete, usually five spots present, one of which, between nervures 4 and 6, rises from the margin and extends inwards about twice its own length. This spot was called by Reverdin the "rectangle allongé." Ground-colour, various shades of reddish-brown and orange; nervures distinct, appearing to be outlined in a lighter shade of the ground-colour, this being the result of the absence on the nervures of the darker scaling which underlies the ground-colour over the other areas of the wing.

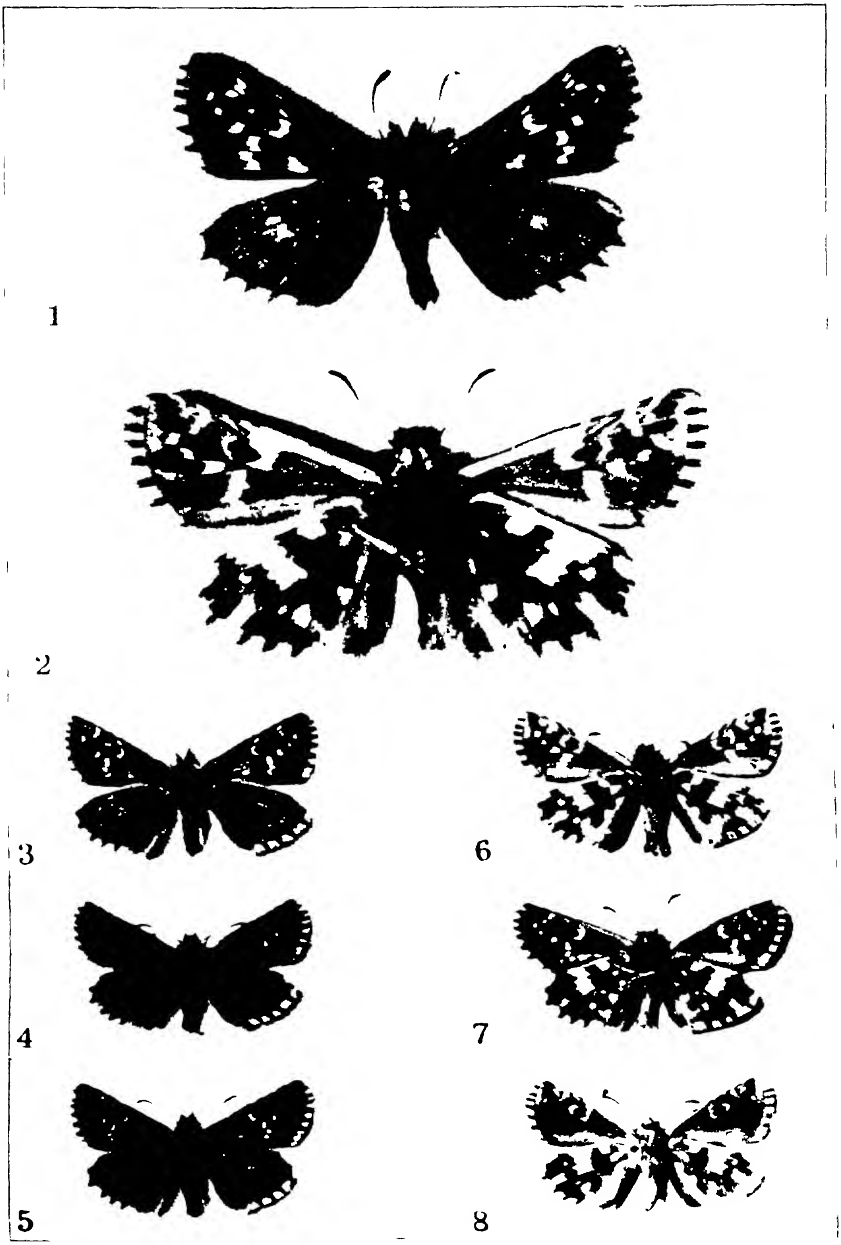
Comparison with the other Species of the Group.—There is seldom much real difficulty in separating *carlinae* from the other two species of the group, though the superficial resemblance to *fritillum* is considerable. From *serratulae* the ground-colour of the underside of the hind-wings will usually be sufficient to distinguish *carlinae*, one or two other useful points to remember, in the event of finding a specimen of *carlinae* more or less yellow on the underside, are: the 3rd basal spot roundish (occasionally square) not elongated; the presence of the rectangle allongé; and the distinctness of the nervures; the latter character on the underside of the hind-wings, as, of course, the two former also.

With *fritillum*, in spite of the apparent similarity, there should be little or no trouble either. In the field the question can hardly arise, as the two species—to our present knowledge—never occur together, and are usually well separated by altitude. The latter point, however, apparently does not hold in south-eastern France, *fritillum* being recorded at Digne at 2000 ft. and over, and at Celles (south of Grenoble) at 2700 ft. I have numerous specimens from the latter locality, taken by Chapman. *Carlinae* occurs at Bourg St. Maurice at 2700 ft. From this locality also, I have numbers of specimens taken by Chapman. These two localities are at least 70 miles apart, but *carlinae* occurs in many places in the Dauphiné Alps, much nearer Celles—for instance, La Grave—and *fritillum* doubtless penetrates up many valleys to the east. It is therefore perfectly possible that the two may occur in very close proximity on the westerly slopes of the Savoie or Dauphiné Alps; and, in view of the fact that we know *carlinae* can descend to levels to which *fritillum* can rise, records from those regions must be very carefully established.

The following points will distinguish *carlinae*. On the upperside of the fore-wings the discoidal lunule is seldom very broad, and has its outer edge concave; only one subcostal spot is present. On the underside of the hind-wings the 2nd basal spot is much smaller than the 3rd, and the rectangle allongé is present; the ground-colour is uniform, not strongly mottled with darker.

Comparison with other Approximating Species of the Genus.—The only species of the genus, outside the group, which at all resemble *carlinae* are *onopordi* and *armoricanus*. The latter never occurs with *carlinae*, and except for the coloration of the underside there is no real similarity. The colour even is only on rare occasions at all near to the true *carlinae* shade. A comparison with the description which has been given of *carlinae* should make it quite impossible to mistake such a specimen of *armoricanus* for the former.

Onopordi may fly on the same ground as *carlinae*, but if it does (which is doubtful) it will usually be over before *carlinae* is well out. An aberration of *carlinae* with a projecting inner edge to the central spot of the median band



[illegible] *Photos. . C S. Barren*

Hesperia carlina

1 Upperside, × 2 2 Underside. 2

Natural size

3 Laquin Tal Simplon Pass 6 Zermatt
4 (ab) Laquin Tal Simplon Pass 7. Kandersteg
5 Zermatt. 8 Zermatt

may be somewhat puzzling if one knows that it might be *onopordi*. *Carlinae* is, however, a considerably larger insect; the concave outer edge of the discoidal lunule on the upperside of the fore-wings, the rectangle allongé and the smaller 2nd basal spot—and even the ground-colour—on the underside of the hind-wings, combined with the absence of black outlining to any spots on the underside, should make certain identification possible. The straight outer edge of the discoidal lunule is very constant in *onopordi*; as is the mottled ground-colour and black edging to the white spots, and the characteristic shape of the 1st spot of the median band on the underside of the hind-wings.

Carlinae on rare occasions (very rare, fortunately) develops a yellowish tint somewhat—though not really—the same colour as the underside of the hind-wings in *alveus*. I do not think anyone familiar with the two species would be deceived by this colour, which has always a brownish shade in it not seen in *alveus*; all the same, one must note that all the distinguishing features of *carlinae* which have been mentioned already occur singly in *alveus* (excepting the typical ground-colour of the hind-wing underside); it must therefore be on the presence of two or more of these features that one relies for the recognition of the species. On the underside of the hind-wings the following points distinguish *carlinae*: the nervures are as a rule more marked than in *alveus*; the 3rd basal spot is rarely so heavy and square, the 2nd basal spot smaller, and the rectangle allongé present; on both upper and undersides the outer edge of the discoidal lunule is strongly concave; and lastly, the outer margin of the fore-wings is slightly rounder in *carlinae*. It may sound very confusing to say that any of these characters may appear in *alveus*, but it is really not so in point of fact, for, even if one is present, it is astonishing how quickly the absence of the others strikes the eye; also, as previously mentioned, the typical ground-colour of the underside in *carlinae*, though variable, always retains a characteristically deep shade, and as a rule enables the specimen to be recognised at a glance.

Sexual Dimorphism.—The ground-colour of the ♂ on the upperside is blacker than that of the ♀, the former is also more strongly marked, and shows less tendency to loss of spotting. The upperside of the ♀ is more or less heavily scaled with golden-yellow, often with a greenish tinge; ♂ with, ♀ without a costal fold on the fore-wings.

Variation.—Like other purely alpine species the variation of *carlinae* is of a restricted character, no pronounced races being known. It, however, shows an extended range in aberrational forms. On the upperside one sometimes finds specimens without any white on the fore-wings, and every possible intermediate form between that extreme and a well-marked typical specimen exists. On Plate XXXV, figs. 1–5 show a representative series of ♀s. The 1st is what may be called a very strongly marked specimen for that sex; 2 is an average specimen; 3 by no means a rare form, with the last spots of the median row and the discoidal lunule present; 4 and 5 are rarer, the discoidal lunule having almost disappeared. Plate XXXIV, fig. 4, is an unusually poorly marked specimen for a ♂; it is doubtful if the extreme form without any white occurs in that sex. On the underside the most frequent form of variation is found in the median band; this gives us:

ab. **extensa**, Warr. (Pl. XXXV, figs. 7–12.)

Specimens in which the inner edge of the central spot is not straight, but projects in varying degrees towards the base of the wing.

This aberration, though common, is worthy of careful notice, on account of the likeness to *onopordi* it gives the specimen. It assumes an immense variety of formations, and is practically never similar in two specimens. The photographs on Plate XXXV show six very characteristic specimens, of both sexes; in fig. 7 the inner edge of the central spot is still almost straight, but even so, the typical look of the specimen is affected, though this is in part due to the aberrant form of the 3rd basal spot. It may be noted that there is a strong tendency to variation in this basal spot in specimens of the *extensa* form.

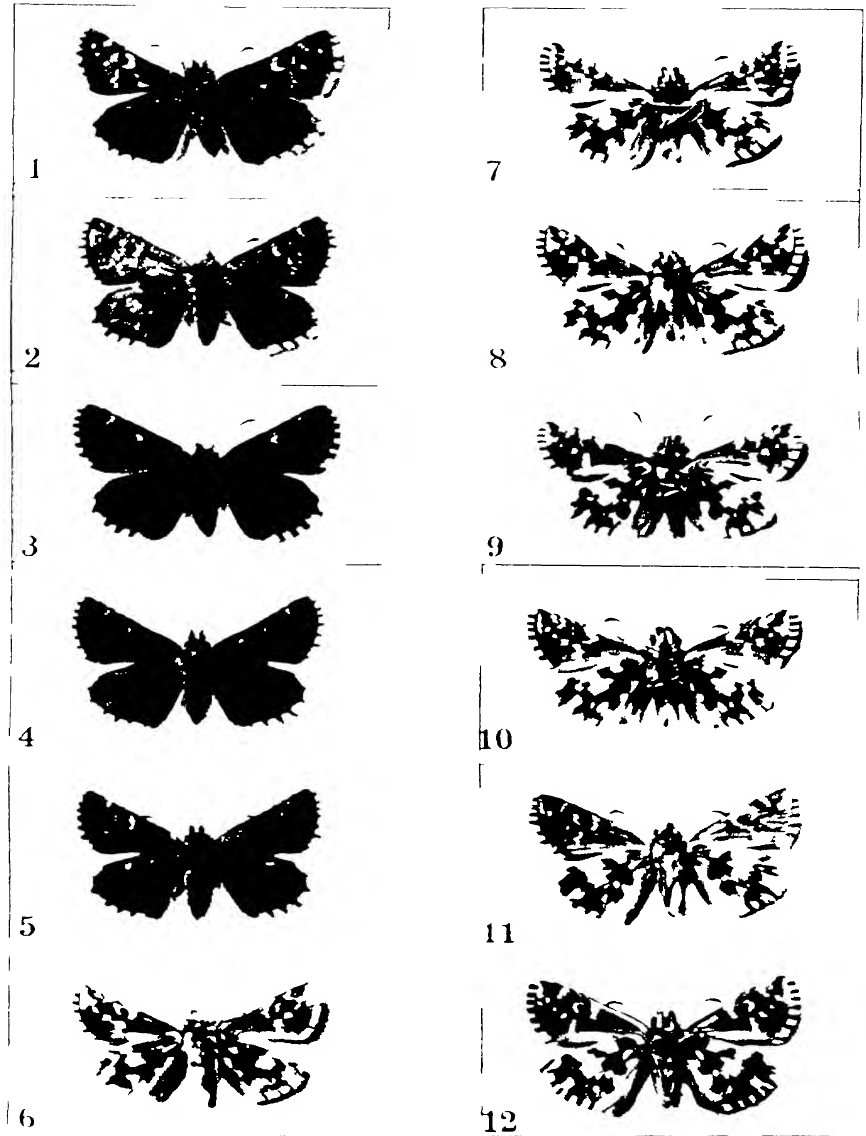
ab. **fasciata,** nov. (Pl. XXXV, fig. 12.)

Specimens in which the spots between nervures 2 and 4 in the median band on the underside are well developed (instead of being absent or very small), giving the band the appearance of being continuous from side to side of the wing. This aberration seems to be confined to the ♀, in which the extreme form is by no means rare, and transitional ones, such as fig. 11, Plate XXXV, fairly common; in the ♂ the nearest approach to it seem to be specimens such as fig. 9. Aberrant forms with a reduction, or loss, of white on the underside are very rare, the specimen shown at fig. 6 with the 3rd basal spot almost non-existent being most unusual.

The range of shades in the ground-colour of the underside of the hind-wings is probably greater than in any other species, and forms a very interesting study for anyone who has taken the species in a number of different localities. I have a fine series of specimens, especially selected from the point of view of colour, which start from a fine, light red-orange, and pass through orange and yellow-brown to a deep chocolate-brown. Some of the pronounced shades are so striking that I have no doubt they would be (some have been) considered worthy of names by many entomologists, but there does not seem any real use in giving a name to a shade of colour in a variable species like *carlinae*; if the species is one which is very constant as to colour, and some very different shade occurs constantly, it would be a different matter, but where we have countless different shades passing imperceptibly from one to another, it becomes merely a source of confusion—no matter how distinct the extremes may be—to apply names to any one shade, for it is quite impossible to limit the range of colours which would be covered by the name. It seems sufficient to record the fact that collectors must expect to find among the normal red-brown *carlinae* specimens with the underside coloured as in any other alpine *Hesperia,* and a variety of other shades as well. (The names which have been given to colour varieties will be found in the Synonymic List, Part XII.)

DATE OF EMERGENCE AND DURATION OF FLIGHT PERIOD.—*Carlinae* is entirely single-brooded, emerging in late July and early August, exceptionally in early seasons appearing in mid-July. The duration of the flight period seems to be some three or four weeks. No matter what the altitude, it is always the last species of *Hesperia* to emerge, which is an interesting point of similarity with *fritillum,* for in its lowland habitats the latter is also the last representative of the genus to appear.

DISTRIBUTION.—*Carlinae* is confined to the western Alps, and how far it extends in an easterly direction is very uncertain. It is absent from eastern Switzerland, there is no authentic record of its occurrence in the Grisons, but there is a specimen labelled Austria in the British Museum collection. I have been unable to find any other Austrian examples; and, apart from that one specimen, the most easterly locality known for the species is Fusio in the Ticino.



Hesper[illegible]

Natural size

1 Binn, Valais
2 Zermatt
3 ab. Zermatt
4

6 ab. Simplon Pass
7 (ab. *extensa* Val d'Herens, Valais
8 Locality unknown
9 Kandersteg
10 Simplon Pass
11 Locality unknown
12 ab. *fasciata*

This makes one wonder if the Austrian specimen is a mistake of labelling. The vertical range of *carlinae* in the Alps is considerable. Most abundant between 4500 ft. and 6000 ft., it extends far above and a little below these levels. In many places it is wanting over 7000 ft., but in others it often passes that altitude. The highest records for the species are: Col de Torrent 9600 ft. and Bricolla Alp 8000 ft. (Chapman); the lowest in Switzerland, Engelberg, about 3400 ft. (British Museum coll.); in France, Bourg St. Maurice 2670 ft. (Chapman); in Italy, Pre St. Didier 3250 ft. (Chapman). The Bourg St. Maurice record is exceptionally low, and it is likely that some of Chapman's specimens came from higher levels in that neighbourhood; still it is evident that towards the south *carlinae* comes lower than it does in Switzerland. It is found in the extreme south of the Maritime Alps both in France and Italy, and this probably is the southern limit of its range; for though Verity notes in the *Bollettino* of the Italian Entomological Society for 1913 that he has a single specimen, a ♀, taken on the Monte Majella (Abruzzi), which he suggests is *carlinae*, he remarks that, as it is a ♀, he is not certain on the point. If the species really occurred in that district more specimens must have been found, for wherever it does occur *carlinae* is always abundant, and Querci does not record it from Central Italy. One or two authors have stated that the species occurs in the mountains of Arragon, but I can find no confirmation of this, and Rambur does not mention any Spanish locality.

Localities:—

Austria.—Austria (British Museum coll.). (Wants confirmation.)

France.—Pralognan (Tring Museum coll.); Abriès (Sheldon, Chapman); Larche (Wheeler, Chapman); La Grave; Mt. Brevent; Allos; Lavancher; Bourg St. Maurice; Lautaret; Trelechant; Col de Montets; Val d'Isère (Chapman); Mont Revard; Dauphiné Alps (British Museum coll.).

Italy.—Macugnaga; Courmayeur; Val Véni; Pre St. Didier (Chapman); Valdieri (Reverdin); Vallasco; Dronero (Verity); Campiglio (British Museum coll.).

Switzerland.—Zinal (Reverdin); Zermatt (Reverdin, Warren, etc.); Bricolla Alp; Simplon Pass; Rhone Glacier; Ferpècle; Vissoye; Saas Fee; between Arolla and Haudères; Piotta; Mattmark; Col de Torrent (Chapman); Engelberg (Chapman, British Museum coll.); Fusio (Tring Museum coll.); Handeck; Anderegg (British Museum coll.); Bérisal (Wheeler, Sheldon); Steinental (Wheeler); between Fiesch and Eggishorn Hotel; Binn; Saflischtal; Albrun Pass; Ritter Pass; Kandersteg; Laquin Tal; Riffel Alp; Lac Tanay (Warren).

Hesperia fritillum, Schiffermüller. (Pl. XXXVI.)

Identification.—*Genitalia.* (Pls. XXXI, figs. 2 and 4; and XXXIII.) The genitalia of this species were dealt with in detail in connection with the last (*carlinae*).

General features.—Size, 30–32 mm. There is little individual variation in *fritillum* as to size, but locally, as for instance in Sicily, it sometimes produces a slightly smaller form, about 28 mm. *Upperside:*—Fore-wings: discoidal series incomplete, 3rd spot wanting, 4th (discoidal lunule) very broad and with practically straight inner and outer edges; median row complete, all the spots large and more or less square; outer row wanting; two subcostal spots present, situated immediately above the discoidal lunule; discal spot present, but narrow and often faintly marked. Hind-wings: 2nd and 3rd basal spots usually visible; median band complete and distinct; marginal row complete, slightly less distinct than the median band. *Underside:*—Fore-wings: first three spots of discoidal series wanting; discoidal lunule and median row very strongly marked, and standing out very clearly on a dark background; discal spot narrow, sharply defined and clear; one subcostal

spot occasionally discernible. Hind-wings: basal spots present, 2nd equal in size to 3rd; median band complete, but spots between nervures 2 and 4 usually small, inner edge of central spot straight; marginal row composed of four or five small spots, that between nervures 4 and 6 square, and often nearly separated from the margin by the ground-colour. The latter is a deep reddish-brown, of uneven density, many areas showing darker, giving the whole a mottled appearance. Nervures very distinct, outlined in a lighter shade of the ground-colour.

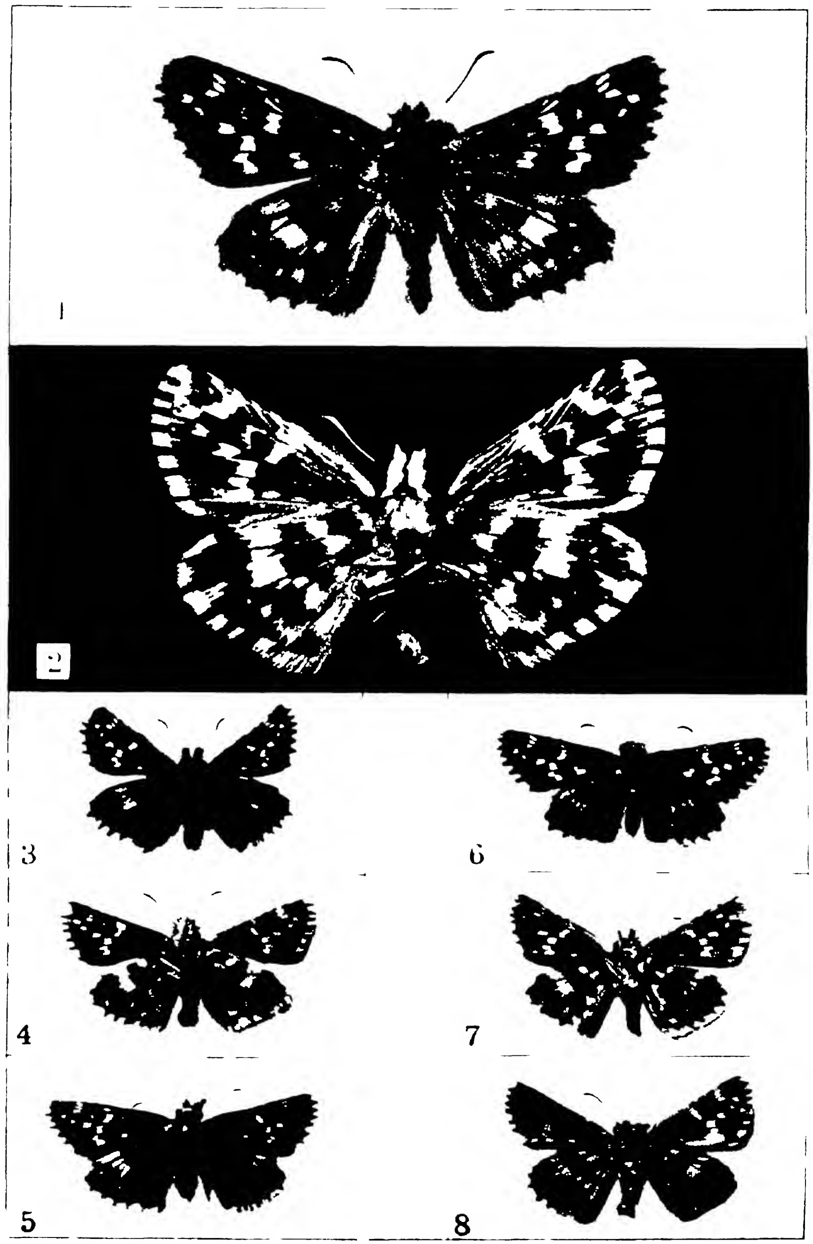
Comparison with the other Species of the Group.—*Fritillum* has already been referred to in connection with *carlinae*, so it will only be necessary to note briefly the main characteristics which distinguish it from the latter.

On the upperside, the square formation of all the markings on the fore-wings, especially the discoidal lunule, with its almost straight edges, and the presence of two subcostal spots. On the hind-wings, the very broad and distinct median band. Underside: hind-wings; the size of the 2nd basal spot, nearly or quite equal to the 3rd, the more mottled ground-colour, and the want of the rectangle allongé of *carlinae*. The corresponding spot in *fritillum* is, as already noted, square, hardly ever longer than it is broad, and often almost obliterated by the ground-colour. It must be noted that the second subcostal spot on the upperside of *fritillum* is not infrequently wanting, when it is present, however, it is a very reliable character.

From *serratulae*, typical *fritillum* is of course at once distinguished by the beautiful ground-colour of the underside of the hind-wings; unfortunately this frequently gives place to a greyish or brownish colour, the former being sometimes a little yellowish and in consequence similar to *serratulae*, *alveus*, etc. Such specimens can be distinguished from *serratulae* by the straight-edged discoidal lunule, the great breadth of all the white markings on the upperside, and the distinctness of the nervures on the underside of the hind-wings, and the mottled character of the ground-colour of the same.

Comparison with other Approximating Species of the Genus.—In this connection we are only concerned with *alveus*, *armoricanus* and *foulquieri*, for the size and extent of the white markings render confusion between *fritillum* and the species of the subgenus *Hemiteleomorpha* impossible, in spite of the somewhat similar coloration of the underside. Of the three species mentioned, *armoricanus* alone approaches *fritillum* in coloration, but to no very great extent, and it is therefore with the abnormally coloured specimens of *fritillum* that we are principally concerned. These sometimes come fairly close to *alveus*, etc., though usually they are not quite so yellow; the underside, however, in spite of the change of colour, remains somewhat mottled, and this fact is of great help in distinguishing *alveus* and *armoricanus*. To take these two first. *Fritillum* is best recognised by the square white markings of the fore-wings and the great width of the straight-edged discoidal lunule. The clear median band on the upperside further distinguishes it from *alveus*, but is less use in connection with *armoricanus*. On the underside of the hind-wings the smaller basal spots and greater prominence of the nervures are very different from *alveus*, but again of less use when comparing *armoricanus*. From the ♂s of the latter, *fritillum* ♂s are undoubtedly best distinguished by the markings of the fore-wings alone; the ♀s, to a considerable extent, can be distinguished by the greater prominence of white on the upperside of the hind-wings also; this being but poorly developed in *armoricanus* ♀s.

Some specimens of *foulquieri* can be troublesome, for the ground-colour of the underside of the hind-wings in that species may be a little mottled, and rare



J. bale ... Photos ... A ... Ione ... ... Warren

Hesperia fritillum

1 Upperside ? 2 Underside, × 2

Natural size

3. ♂. Eclepens. (Vaud)	6	s sp *iberica*	Tragacete
4. ♂. „	7	„ „	Albarracin
5 ♀. France	8	„ „	Tragacete

specimens of the ♀ (? ♂ too) may have a very *fritillum*-like discoidal lunule (see figs, 5 and 6, Pl. XLVII). Such specimens are unusual, and the formation of the lunule is not exactly as in *fritillum*, but in spite of them *fritillum* can almost always be identified by: the straight edges of the discoidal lunule; the square heavy spots of the median row on the upperside (these spots alone would show that the figs. 5 and 6 of *foulquieri* just mentioned were not *fritillum*); the sharply defined, narrow discal spot on the underside; the dark ground-colour of the basal area of the fore-wings underside; and the smaller basal spots, also underside. In *fritillum* these latter spots are never as large as the spots of the median band; in *foulquieri*, etc., they usually are.

SEXUAL DIMORPHISM.—The difference between the sexes in this species is very slight. The ♀ is usually without any lighter scaling on the basal area of the upperside of the fore-wings, which is generally present in the ♂. The latter has, and the ♀ has not, a costal fold on the fore-wings.

VARIATION.—The variation of *fritillum* is of a more important character than that of *carlinae*, which is what would be expected, considering its wider distribution.

s.-sp. **iberica**, Gr.-Grsh. (Pl. XXXVI, figs. 6–8.)

This subspecies was described as a variety of *cinarae* by Grumm-Grshimailo, and afterwards attributed by Staudinger to *alveus*, which course was followed by Mabille. Reverdin, however, proved by dissection that it was a form of *fritillum*. The type specimens are in the British Museum collection, and come from Andalusia; they correspond exactly with any other Spanish specimens I have seen. I have dissected several, and so had Chapman, the result being always the same: unquestionable *fritillum*. It is a very beautiful form, and differs from the type as follows. On the upperside of the hind-wings the median band and marginal row of spots are cream-coloured and not white, forming a conspicuous contrast to the white of the spots on the fore-wings. On the underside the ground-colour of the hind-wings has become reddish-ochreous, in which the latter predominates, and which to a greater or less extent shades the whole of the underside: body, legs, inner margin and fringes of hind-wings, costa, basal area and apex of fore-wings. The basal spots, median band and marginal row are no longer pure white, but creamish or warm ochreous, and in very extreme examples even the spots on the fore-wings are creamish too. The coloration of the underside is somewhat variable, but any specimen placed beside one from Central Europe makes a remarkable contrast, the coloration of the latter looking very cold in comparison. In the specimens figured, the difference of colour hardly shows in the photograph, but it can be seen that the spots on the hindwings and the light parts of the fringes, as well as the basal area of the fore-wings in figs. 7 and 8, look darker than the corresponding features in fig. 4. *Iberica* is widely distributed in Spain, where, so far as I can ascertain, it replaces the type; it occurs as an aberration in the south of France.

race (? s.-sp.) **siciliae**, Obth.

This Sicilian race differs from the type only in size and the size of the white markings. It is described as being smaller than French *fritillum*, with the white spots on the underside of both wings reduced in size too. The specimen which Oberthür figured was a little smaller than the ordinary Central European form, and the white markings on the underside were somewhat reduced.

This is perhaps merely on account of the reduction of size. It is not a very striking form, and there are not sufficient data available to assure one that it entirely replaces the type in Sicily, or even that it does so in certain localities in the island. I therefore retain it as a variety of doubtful standing, and leave it to future observation to settle the point.

race **herrichii,** Obth.

This is a race in which the ground-colour of the underside of the hind-wings is more greyish-yellow in tone, with little, or scarcely any, of the typical reddish-brown shade. Oberthür notes it as being "commoner at Digne than the type." The figure he gives of it is not up to the usual standard of his illustrations (*Lépidop. Comp.*, Fasc. iv, pl. 56, fig. 508). It is too yellowish in colour, and the shade too even in density (reminding one of *alveus*, etc.) instead of having the mottled effect always present in *fritillum*, no matter what the colour is. Reverdin notes that this variation in colour is by no means confined to Digne, but occurs almost everywhere the type does. It is not possible to fix an exact shade of colour as constituting *herrichii*, and I doubt if any specimens will ever be found the exact shade of Oberthür's figure. It will, however, be safe to refer to this name all specimens which have lost to some extent the typical red tone and become greyer or more yellowish. The white markings of the underside, however, remain white, in spite of the change in the ground-colour. I have one or two specimens from Digne in which the median band is slightly yellowed, but this is not at all usual, and is more a transition to *iberica* than the result of the *herrichii* line of variation. Such transitional specimens occur in many localities in S. France.

In the aberrational line there is not much to be noted. I have never seen what would be called a really striking aberration of the species. On the upperside the distinctness of the marginal row, and the basal spots, and the occasional loss of one of the subcostal spots, are the most usual forms of aberration. A single specimen from Celles, taken by Chapman, has the basal area of the upperside of the fore-wings, as far as the discoidal lunule, suffused with white. This apparently is a very rare form. On the underside of the hind-wings the most variable feature is the size of the spots of the median band, between nervures 2 and 4; occasionally quite absent, normally small, often well developed and entirely uniting the band.

ab. **extensa,** Warr.

In this the inner edge of the central spot of the median band, on the underside of the hind-wings, is not rectilinear, but projects slightly towards the base of the wing.

This aberration is very rare in *fritillum*, and no very extreme form seems to occur; the most usual form is that with a very slight projection, just sufficient to break the typical straight edge. In this particular *fritillum* is very different from *carlinae*; for it will be remembered that the tendency to this form of variation is a marked feature of the latter, and that it occurs more frequently in a highly developed form in *carlinae* than in any other species of the sub-genus.

Date of Emergence and Duration of Flight Period.—The date of emergence is one of the most remarkable characteristics of the species. It is single-brooded, and essentially a low-level species, and yet it does not appear until the end of July or the beginning of August, generally accompanying the second brood of the other low-level species. The fact that it inhabits southerly

and often very hot localities in the south of France, Spain and even Algeria, makes this all the more remarkable. Records of the capture of *fritillum* in May and June have often been published in the past, but these records, when examined, invariably prove to be the result of incorrect identification. One alone seems to be well founded; it refers to two specimens in the Oberthür collection obtained from the collector V. Cott, and supposed to have been taken on May 11th at Digne. Cott must have taken hundreds of specimens of *fritillum* at Digne in August and September during many successive years, and the possibility of a mistake in the labelling of the specimens must not be altogether ignored; but even assuming them to have been taken in May, these two specimens alone, as opposed to the sum-total of captures at Digne and everywhere else, are no reason for doubting that *fritillum* is entirely a single-brooded species, in spite of its very unusual date of emergence. A few typical dates may be of interest, showing, as they do, the same characteristics from the most northerly localities inhabited by the insect to those in the extreme south. Kreuznach (Germany), late July to September; Sofia, August; Bourg Argental, August 15th, 1913; San Misallo, September; Tramelan, August (Reverdin); Fontainebleau, August; Grésy-sur-Aix, August 23rd; Celles, August; Puerto Losilla, August 7th; Tragacete, July 18-26th; Albarracin, July 28th–August 6th (Chapman); Eclépens, August 9th-14th; Digne, August and September (Wheeler); Angoulême, September (Oberthür). In Italy always found in August and September (Verity). These dates give a fair idea of the length of the flight period, though probably, judging from them alone, one would conclude it was longer than really is the case. Four weeks is the outside length of the time that the insect will be on the wing in any one locality, and very often it completely passes in three weeks or even less. The German record probably refers to the extreme dates in different seasons.

DISTRIBUTION.—*Fritillum* is evidently a widely distributed species, by no means confined to quite southern localities, as it is very generally supposed to be. The eastern and northern limits of its range may be said to be unknown, which is very surprising for such a finely marked species. It apparently occurs in Germany, Austria and the Balkans, but to what extent we have neither records nor specimens to help us in forming an opinion. It extends southwards to Sicily and Algiers, thus completely encircling the habitat of *carlinae*.

Austria.—Austria (Reverdin).
Bulgaria.—Sofia (Reverdin).
France.—Bourg Argental; Gex; Doubs (Reverdin); Digne (Chapman, Reverdin); St. Zacharie (Reverdin, Tring Museum coll., etc.); Fontainebleau; Grésy-sur-Aix; Celles (Chapman); Angoulême (Oberthur).
Germany.—Kreuznach; Ulm (Reverdin).
Italy.—San Misallo (Reverdin); neighbourhood of Florence (Verity).
Italy (Chapman coll.).
Sicily (Oberthür, Verity).
Spain.—Andalusia (British Museum coll.); Puerto Losilla; Tragacete; Canales (Chapman); Albarracin (Sheldon, Chapman); Vores del Bastareny; Guardiola-Bagá; Serres de Berti (Sagarra).
Switzerland.—Tramelan (Reverdin); Eclépens (Wheeler, Reverdin).

III. ALVEUS Group.

STRUCTURAL CHARACTERISTICS.—Tenth sternite in male incomplete, lateral apophyses short, and more or less triangular in form; cuiller highly developed on lines of *serratulae* group, very large, equal to, or more than, half the total

dimension of the clasp; the proximal edge uneven, uniting with the stylifer at about one-third its length; style short, slender and curved. Ventral line of clasp concave.

Characteristic Facies.—Underside hind-wings: 3rd basal spot more or less square; central spot of median band with straight inner edge.

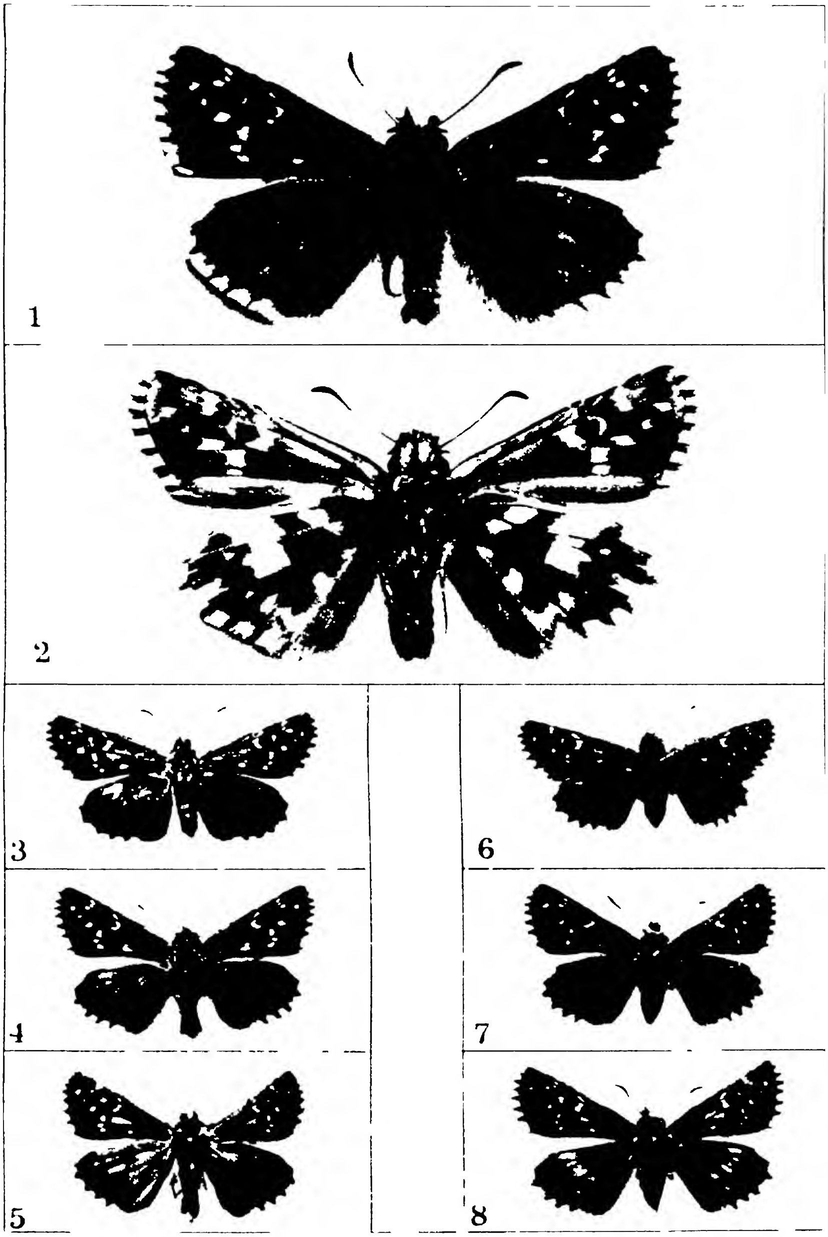
Hesperia alveus, Hübner. (Pls. XXXVII, XXXVIII, XXXIX, XL, XLI, XLII and XLIII.)

Identification.—*Genitalia.* (Pl. XLIV, fig. 1.) The uncus long and slender. The lateral apophyses of the triangular shape peculiar to the species of this group, but with their distal margins concave. The great feature of the clasp is the cuiller. Its outline forms slightly more than half a circle, and the curve from the summit to the base is quite regular. The dorsal line of the cuiller is straight for a short distance, sloping slightly down from the summit of the process to the apex, which is a blunt angle usually armed with fine spines. The point of this apex is rarely on a level with the summit of the cuiller, never above it. The free portion of the proximal edge of the cuiller is normally almost perpendicular, and quite straight. The greatest depth of the cuiller (vertically) is a little greater than the greatest breadth (horizontally). The style is very short, and bends over near its base. Antistyle directed downwards, usually terminating in a broad hook pointing towards the base of the clasp.

Alveus is easily distinguished from *armoricanus* or *foulquieri* by the various points which have just been mentioned. Those which should be especially noted when comparing with *armoricanus* are: the concave distal edge of the apophyses; the straight and perpendicular aspect of the free portion of the proximal edge of the cuiller; the blunt apex which is below, or on a level with, the summit of the process, but never actually constituting the summit itself; the great breadth of the cuiller; and lastly, the blunt termination of the hook of the antistyle.

The characters contrasting most sharply with *foulquieri* are, as before, the shape and dimensions of the cuiller and the antistyle, and that the side pieces, or stems, which support the lateral apophyses are shorter in *alveus* than in *foulquieri*. The cuiller in *alveus* stands exactly mid-way between that structure in *armoricanus* and *foulquieri* in several respects. Whereas in *alveus*, as already noted, the greatest breadth of the cuiller is a little less than its greatest vertical measurement, in *foulquieri* the two are almost exactly the same, and in *armoricanus* it is only a little more than half the greatest vertical measurement. In *alveus* the free portion of the proximal edge of the cuiller is almost perpendicular and straight; in *foulquieri* it slopes forwards towards the harpe, and in *armoricanus* it is concave and slopes backwards away from the harpe. The whole outline (dorsal, distal and ventral) is in *alveus* more than a semicircle; in *foulquieri* elliptic. The form of the apex is variable in *alveus*; it occasionally assumes a formation very similar to *foulquieri*, as can be seen on Plate XLV, figs. 1 and 2. Although these figures represent the extreme form of two subspecies of *alveus*, the same form occurs in typical *alveus* from numerous localities. It will be mentioned again in connection with the subspecies themselves.

General features.—In size *alveus* may be said to be a variable species, though this will not be noticeable, as a rule, in single localities. The average size in Central Europe is 30–35 mm. At high altitudes we get a race which is considerably smaller, 28–29 mm. This seems to be the smallest variety of the species. Another small race occurs in Central Italy, which comes between the two, at 29–31 mm.; the larger size being but slightly greater than the smallest form of the average in Central Europe. In the Pyrenees we find the largest constant form 32–36 mm., while single specimens reach and even pass this size, *e.g.* in the Chapman collection there was a specimen of 38 mm.—locality unknown. *Upperside*:—Fore-wings: dark brown



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Hesperia alveus

1. Upperside × 2. ♂. 2. Underside × 2 ♂.

Natural size

3. ♂. Gemmi Pass 6. ♀. Lenzerheide (Grisons)
4. ♂. Ofen Pass 7. ♀. Albula Pass
5. ♂. Vernayaz (Valais) 8. ♀. Vernayaz (Valais)

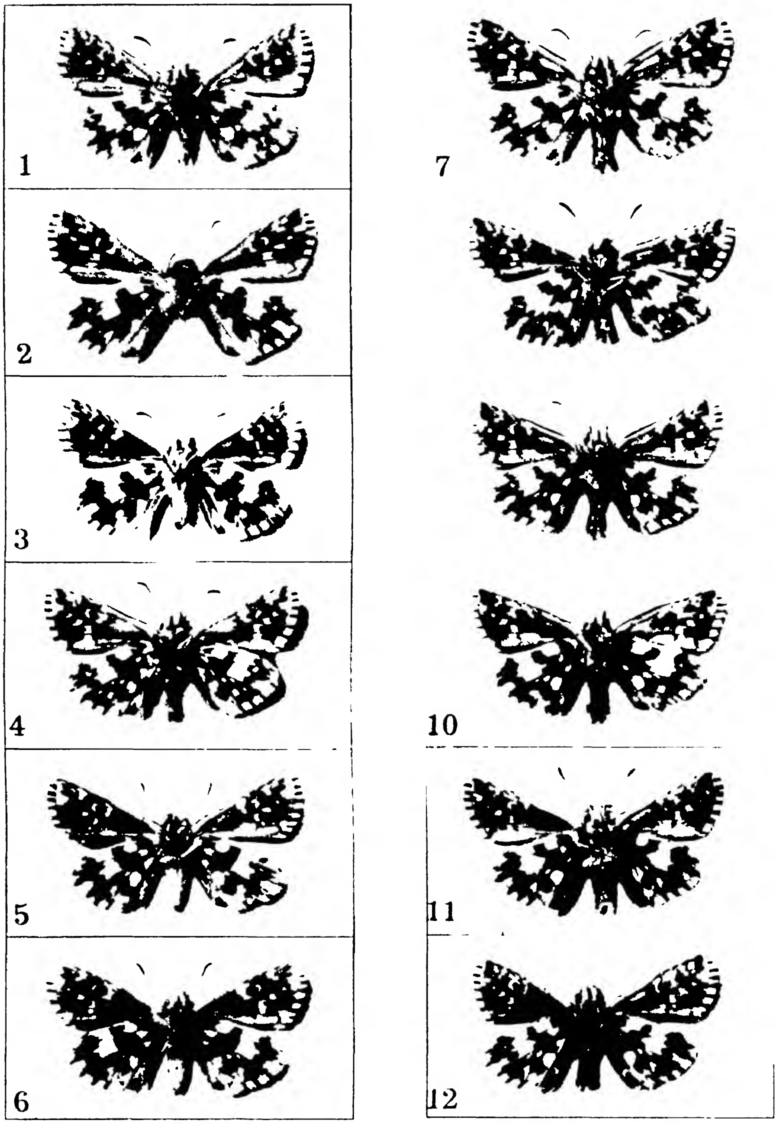
or black, very uniform, with little or no light scaling at the base. Discoidal series incomplete; 3rd spot always, 2nd often, wanting; discoidal lunule with straight or slightly concave outer edge; median row complete, composed of irregularly shaped spots of variable sizes, with the 4th and 6th standing well away from the 3rd and 7th respectively; outer row wanting; discal spot present, indistinct; one subcostal spot present, very rarely two. Hind-wings: black with shades of median band and marginal row of spots showing, to a greater or less extent. (Variable.) *Underside*:—Fore-wings: discoidal lunule distinct, variable in size, outer edge straightish, seldom deeply concave; median row complete; discal spot fine and distinct, set well back from the discoidal lunule. Hind-wings: basal spots present, large, 3rd more or less square and largest; median band complete or incomplete, central spot with straight inner edge; marginal row composed of five scattered spots, variable in size; ground-colour yellowish, sometimes with a brownish, sometimes with a dull greenish tinge, of fairly—but not absolutely—even density; nervures more visible against the ground-colour than between the white markings, but not standing out very prominently, and therefore not catching the eye readily.

Comparison with the other Species of the Group.—It must be clearly understood that this comparison is drawn between typical *alveus* and the typical forms of the compared species. The various local races of *alveus* are so different that they will have to be dealt with separately. We have two species to consider: *foulquieri* and *armoricanus*. The former is the most difficult species to distinguish from *alveus*, which has a decided tendency to approach *foulquieri*; one often finds single specimens among quite typical *alveus* which are exceedingly good imitations of *foulquieri*. On the whole, the ♂s are fairly easy to identify, but the ♀s are much more difficult, and require considerable experience before one can feel really confident about them. The first thing to note when comparing *alveus* and *foulquieri* is the shape of the wings in each. In *alveus* they are narrower in proportion to their length, and the outer margin of the fore-wings is curved throughout, from the apex to the hinder angle. In *foulquieri* the wings are broader, and the outer margin of the fore-wings is much less curved, and practically straight from nervure 6 to the hinder angle. This point will be very clearly seen in the enlarged figures of the two species on Plates XXXVII and XLVII. In *alveus* the ground-colour of the upperside is a uniform blackish-brown, with a dusting of light grey scales; in *foulquieri* it is more variegated, certain areas being broadly lighter owing to the presence of a considerable quantity of light, almost white scales among the darker ones. This difference is very pronounced among the ♂s. The white spots of the fore-wings in *alveus* are small and of irregular sizes, the discal spot often very inconspicuous, and the discoidal lunule narrow, with a straightish or slightly concave outer edge; whereas in *foulquieri* all the spots are larger and more or less square, the discal spot and the discoidal lunule broader, the latter often resembling a capital I. The hind-wings, usually black with a faint indication of the median band and the marginal row in *alveus*, have in *foulquieri* the basal spots, median band and marginal row all showing very distinctly, sometimes almost white, with little or no dark scaling. All these features render the ♂s of the two species moderately distinct, but the ♀s of *foulquieri* are often less characteristically marked, and the greenish scaling which usually covers the whole of the upper surface of the wings may be found in *alveus* ♀s too, though not a normal feature of that species. Two ♀s, typical of *foulquieri*, are shown on Plate XLVII, figs. 5 and 6. The latter (race *picena*) is obviously *foulquieri*, the short broad wings and the heavy white markings of the hind-wings in connection with the broad discoidal lunule and evenly marked median row of

spots, and the dense green superscaling obscuring the ground-colour, are all very characteristic of the species. Fig. 5, however, a specimen from the locality from which the type specimens came, taken by Foulquier himself, is very like some *alveus* ♀s, for instance that on Plate XXXVII, fig. 8. The latter, although it has a strong look of *foulquieri*, can be distinguished by: the more elongated form of the wings; the perfectly curved outer margins of the fore-wings; the narrower discoidal lunule, which is not as broad as is normal to *foulquieri*; and the position of the spots of the median row, the 4th and 6th well separated from the 3rd and 7th. These spots may occur aberrationally in a similar position in *foulquieri*, but rarely both pairs are affected in the same specimen; normally they are almost or quite touching. Fig. 6 on Plate XLVII shows a ♀ specimen perhaps more difficult to distinguish, but the breadth of the wings and of the discoidal lunule is noticeable, and though the fore-wings are more curved than in the ♂, they still are less curved than in ♀ *alveus*. The underside, too, gives us some help in distinguishing the ♀s of the two species, though, strangely, it is less use in the case of the ♂s. In the most *foulquieri*-like ♀s of *alveus* the ground-colour of the underside of the fore-wings is blackish-grey, with some white suffusion along the inner margin and costa, the fringes white, and the apex tinted the same colour as the ground-colour of the hind-wings. In *foulquieri* the whole underside of the fore-wings is tinted with ochre, including the fringes, and the ground-colour of the hind-wings is ochreous too, and usually yellowish to yellowish-green in *alveus*; this gives the whole colouring a much warmer effect in *foulquieri*, than is ever seen in *alveus*. Another useful character on the underside is the size of the discal spot, generally very narrow and linear in aspect in *alveus*, and normally much broader and with suffused edges in *foulquieri*.

From *armoricanus*, *alveus* is best distinguished by its greater size and, in proportion, smaller white spots on the upperside of the fore-wings, and the absence of distinct white markings on the upperside of the hindwings. Underneath, the ground-colour of the fore-wings is dark, often blackish, and that of the hind-wings yellowish and never orange. The white markings on the underside of the hind-wings in *armoricanus* are reduced in size, in keeping with its smaller size in general; in small specimens of *alveus* (from low levels) this is not so, the white markings retain their normal dimensions. Thus, small *alveus* make a remarkable contrast with *armoricanus* of approximately similar size; for, in the former, we have normal-sized markings of typical *alveus* on both upper- and undersides, and, in the latter, slightly stronger white spotting on the upperside of the fore-wings, and much stronger on the hind-wings, and slightly reduced white markings on the underside of the latter. These distinctions should usually suffice in the case of *alveus*, but there are one or two other distinctive features about *armoricanus* which will be noted in connection with that species. Small specimens of *alveus* are very rare in the lowlands where *armoricanus* occurs, so as a rule size by itself will be sufficient to distinguish *alveus*; also the date of capture is a most valuable aid in identification. Accurate data labels will in numerous cases greatly simplify the identification of various forms of *alveus*, and carefully recorded dates will prevent confusion arising between aberrations of *alveus* and *serratulae* in southern localities.

Comparison with other Approximating Species of the Genus.—With the exception of *serratulae*, no other species approaches at all closely to *alveus*, and of course it is only aberrant specimens of the former that do so. These aberrations of *serratulae* have been already described, so it only remains to



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Hesperia alveus.

Natural size.

1. ♂. Ofen Pass
2. ♂. Verossaz (Valais.)
3. ♀. Tanay (Valais.)
4. ♂. ab. *serratulæformis*. Lenzerheide (Grisons.)
5. ♀. ,, ,, ,, ,, ,,
6. ♀. ,, ,, ,, ,, ,,
7. ♂. ab. *extensa*. Tanay. (Valais.)
8. ♂. ,, ,, Gemmi Pass
9. ♂. ,, ,, Lenzerheide (Grisons.)
10. ♂. ,, ,, ,, ,, ,,
11. ♂. ,, ,, Albula Pass
12. ♂. ,, ,, Zermatt.

consider here the aberrant forms of *alveus*, which sometimes resemble *carlinae* a little too.

Specimens with the 3rd basal spot on the underside rounded in a manner suggestive of *serratulae* (see figs. 4–6, Pl. XXXVIII) can be identified by: (1) the heavier nature of the basal-spots themselves, and of the median band; (2) the character of the nervures, visible against the ground-colour; (3) by the position of the spots of the median row on the upperside, 3 and 4 well separated and 6 well away from 7. In *serratulae*, although a little variable, these spots are usually much closer together, if not touching. In *alveus* their position is very constant. From *carlinae*, the larger size combined with the uniform blackish-brown ground-colour of the upperside; the small sharply-defined white spots of the fore-wings and the almost unmarked hind-wings; the yellowish ground-colour of the latter wings and the broad median band on the underside suffice to distinguish *alveus*; for in *carlinae* the ground-colour of the upperside is variegated by thick scaling of lighter colour in certain areas, the spots having a softer outline and the hind-wings showing a certain amount of marking, etc.

In the very small mountain race of *alveus*, which is often smaller than *carlinae*, these same points hold good; and, in addition, one may note the absence of the rectangle allongé—which is often present in full-sized *alveus*—and the very narrow, often almost invisible, discoidal lunule on the upperside.

From *fritillum* and *cinarae* there will never be any difficulty in distinguishing *alveus*, the characteristic features of both these species being too pronounced. The species of the subgenera *Hemiteleomorpha* and *Teleomorpha* need hardly be taken into consideration, though possibly a beginner might find specimens of the ab. *extensa* (Pl. XXXVIII, figs. 7–12) a little similar to *cacaliae* or *andromedae*. From the former, *alveus* can always be distinguished by the presence of the discal spot, the form and presence of the basal spots, etc.; from the latter, by the absence of the 2nd and 3rd strongly developed and well-separated subcostal spots, and the absence of the well-known exclamation mark on the underside of the hind-wings, only to mention a few of the numerous points of difference.

Sexual Dimorphism.—There is a marked difference in the coloration of the sexes in *alveus*. The upperside of the ♂ is an even blackish-brown with little or no light superscaling; the upperside of the ♀ is always fairly thickly covered with golden scales with a greenish tinge, especially on the basal half of the fore-wings and along their outer margins, and on the median band and marginal row of shaded markings of the hind-wings, while between these areas one sees the ground-colour in dark patches. This scaling is very conspicuous when the insect is freshly emerged, but it soon wears off, and worn specimens might appear to be almost without it. It will be seen, however, on close inspection, that this appearance is only the result of wear and that the scales were originally present. In the ♀, also, the discoidal lunule is often broader than in the ♂, which contrasts remarkably with the tendency to reduction in size of the spots of the median row, the 3rd and 5th being often smaller in the ♀, the latter frequently wanting. The ♂ has, and the ♀ has not, a costal fold on the fore-wings.

Variation.—The variation of *alveus* is of the greatest interest, and at the same time extremely complicated. A species, probably of no great antiquity, certainly of poor stability, with a great tendency to individual variation and an enormous range of distribution, provides one with every requisite for the production of chaotic variation. The different climatic conditions prevailing

in various parts of the Palaearctic area have taken full effect on this impressionable subject, and we see the result in the numerous closely related forms which have attained specific standing. We have still further evidence of its workings in the numerous subspecies, some of which are so developed that they are but little removed from the final step which will separate them definitely from *alveus*. We will consider the subspecies which we have so far been able to define, in order of their apparent importance.

s.-sp. **sifanicus**, Gr.-Grsh. (Pl. XXXIX; genitalia, Pl. IX, fig. 6.)

This is a very distinct form, more eastern than European, well distributed in the Caucasus, but nothing approaching it is known from other parts of Europe at present.

The most characteristic features of the subspecies are on the underside; on the upperside there is little to distinguish it from the type. The outer margins of the fore-wings are possibly a little more curved, especially at the hinder angle; the discoidal lunule is very narrow, practically straight, and sharply defined, and the 2nd spot of the median row is often placed less directly over the 1st, *i.e.* slightly more towards the outer margin of the wing. On the underside the ground-colour of the fore-wings is paler on the whole, the spots of the median row are edged with a very fine black line, and there is a marked marginal white band, very broad at the apex, tapering off to nothing at the hinder angle. (These two characters are sometimes seen in Italian *foulquieri.*) The hind-wings show a combination of the features of *serratulae* and *alveus*. The ground-colour is of perfectly even density, as in *serratulae*; the nervures also show, as in that species, between the white spots and not against the ground-colour. The white markings, however, are more those of *alveus*, but are even heavier and squarer, the basal spots large, the 3rd practically a rectangle, the median band united, the spots between nervures 2 and 4 usually well developed, the marginal row sometimes broad and continuous, but sometimes less so. The white markings on the upperside of the hind-wings are very variable, sometimes very strongly marked and clear, almost white, occasionally as inconspicuous and dark as in *alveus*.

A very interesting point about this subspecies is, that it forms a remarkable transition to the Chinese species *schansiensis*, the characteristics of the underside of the latter being merely a magnification of those of *sifanicus*.

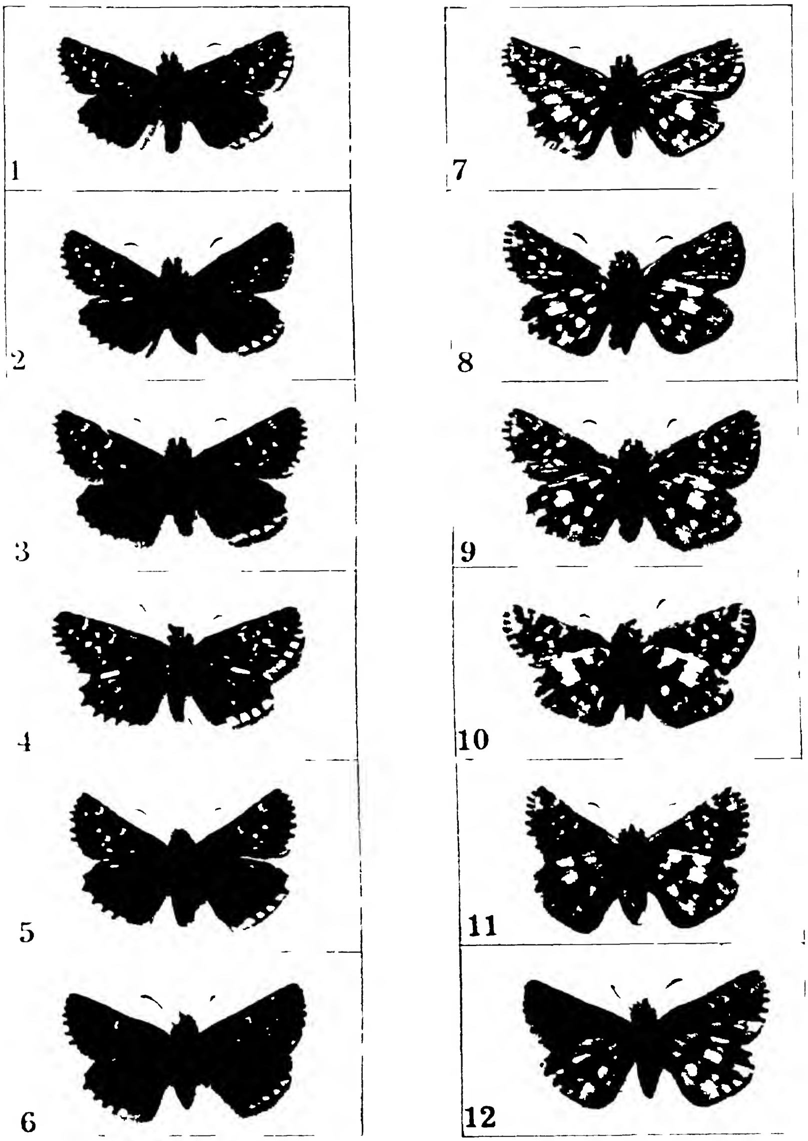
The distribution of *sifanicus* is apparently considerable, though specimens are only known from a very few localities; *i.e.* Achalzig; Borshom; Ararat; Kuban (? only the mountain districts); Adshara (Caucasus); Urmia (Persia); and Kuku Nor (Tibet) (Reverdin).

s.-sp. **accreta**, Vty. (Pl. XL.)

This subspecies is probably the most interesting variety to European entomologists, forming as it does a perfect transition to *foulquieri*, both structurally and superficially.*

Of large size, keeping to, and surpassing, the largest average size of the type, 32–36 mm.

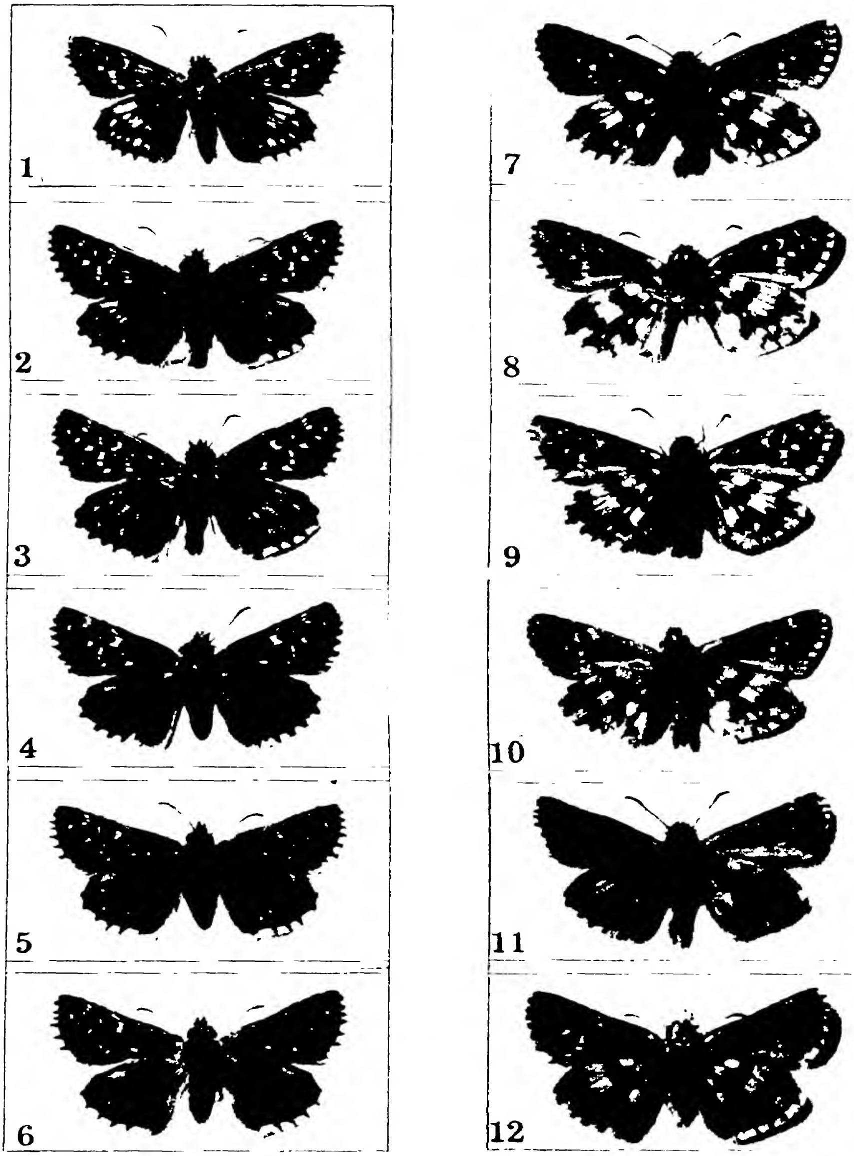
* The original descriptions of this subspecies and the following one (*centralhispaniae*) were vague and inaccurate. I therefore have left the more detailed descriptions of both, which had been draw up more than a year before the publication of Verity's names in the *Entomologist's Record* (vol. xxxvii, pp. 55 and 56). Verity gave, at the same time, the name *grandis* to figures of Oberthür's, of some specimens from St. Martin de Vésubie. These specimens are merely *foulquieri*, to which *grandis* falls. It is not without interest to note that the form of *alveus* found at St. Martin de Vésubie is small and dark, and practically identical with the average Central European form.



Hesperia alveus

Natural size

1 and 7 ssp *iranicus* Adshara
2 and 8 .. .. .
3 and 9 .. , ..
4 and 10 , . Ararat
5 and 11 .. . Caucasus
6 and 12 .. .. Adshara.



J. Bale, S. & D., Ltd. Photos. B. C. S. Warren

Hesperia alveus.

Natural size.

1— 3. ♂. s-sp. *accreta*. Gavarnie.
4— 6. ♀. ,, ,, ,,
7—11 ♂. ,, ,, ,,
12. ♀ ,, ,, ,,

Upperside:—Fore-wings: ground-colour variegated, basal and outer marginal areas thickly scaled with grey in the ♂, and yellow-green in the ♀; white spots of median row larger than in *alveus*, but retaining the same positions as in the latter; discoidal lunule also slightly larger, varying in form as in *alveus*. Hind-wings: strongly marked; median band and marginal row much lighter than in *alveus*, in ♂ white scaled with darker (*i.e.* scales of the ground-colour); in the ♀, yellowish-green. *Underside*:—Fore-wings: ground-colour more variegated than in *alveus*, basal area greyish, spots of median row large. Hind-wings: basal spots and median band very large; ground-colour yellowish, lighter than in *alveus* and less even in density, being slightly mottled with darker in places; the white spots of the median band tend to be outlined in black. Inner margin variable, but most often of a light colour, rarely so dark as in *alveus*. Nervures distinct, and outlined in a lighter shade of the ground colour.

Genitalia. (Pl. XLV, fig. 2.) The genitalia of *accreta* make a remarkable approach to *foulquieri* in the form of the cuiller. This is specially noticeable in the formation of the apex; the free portion of the proximal edge of the cuiller from the apex to the point of junction with the stylifer slopes forward as in *foulquieri*, and in consequence brings the apex much closer to the harpe than in typical *alveus*. The cuiller is also distended ventrally in a manner suggestive of the effect of the same influences that developed the great distal distension in *foulquieri*, and the length of the side pieces which support the lateral apophyses is also somewhat similar to that species. This type of cuiller is more or less constant in *accreta*, though subject to variation within certain limits, some specimens inclining even more to *foulquieri* and others being nearly typical, *i.e.* like *alveus*. The formation is, however, essentially nearer *alveus* than *foulquieri*. The summit of the cuiller is lower than, or level with, the dorsal ridge of the harpe, as is the case in *alveus*, and not well over it as in *foulquieri*; also the greatest breadth of the cuiller never anything like equals its greatest vertical measurement, being usually at least one-fifth less. The broad antistyle, too, is closer to that of *alveus*, as is also the formation of the stylifer.

Habitat:—Gavarnie and Cauteret in the Western Pyrenees; probably widely distributed throughout the range, above 3000 ft.

This beautiful subspecies stands very distinct from the type form in size, markings and coloration; it is proportionately all the more similar to *foulquieri*. In the field it will always be possible to keep *foulquieri* distinct, for, so far as is at present known, the two do not occur together, *foulquieri* being unknown in the Pyrenees. With unlabelled cabinet specimens great care will be required to ensure correct identification.

The principal points which distinguish *accreta* are:—in the ♂: the slightly smaller spots of the median row on the upperside, of irregular dimensions, with the 4th standing well away from the 3rd; the discoidal lunule with less straight edges, seldom assuming the capital I formation; the discal spot smaller and more suffused; the light scaling at the base of the wings is grey and thinly dispersed, rather than white and very dense. On the hind-wings, upperside, the basal spots are only rarely at all visible, and never white and pronounced as in *foulquieri*, and the other white markings are never, or very rarely, as free of dark superscaling as in the latter. In general, the specimens lack the regular appearance of alternating black and white banding so characteristic in *foulquieri*. and the outer margin of the fore-wings is more curved below the apex than in *foulquieri*, but not invariably so. The underside is practically indistinguishable, as are the ♀s, except for the curvature of the outer margins of the fore-wings. To distinguish the ♂s is not so difficult as the description might lead one to

suppose, and some well-marked ♀s can be distinguished too, but as a rule I should hesitate to diagnose either insect if the locality of capture were unknown, unless some specimens of the ♂ were available.

s.-sp. **centralhispaniae,** Vty. (Pl. XLI.)

This subspecies is to some extent a further step on the lines of *accreta*, and the result is without question the most remarkable form of the species known to science.

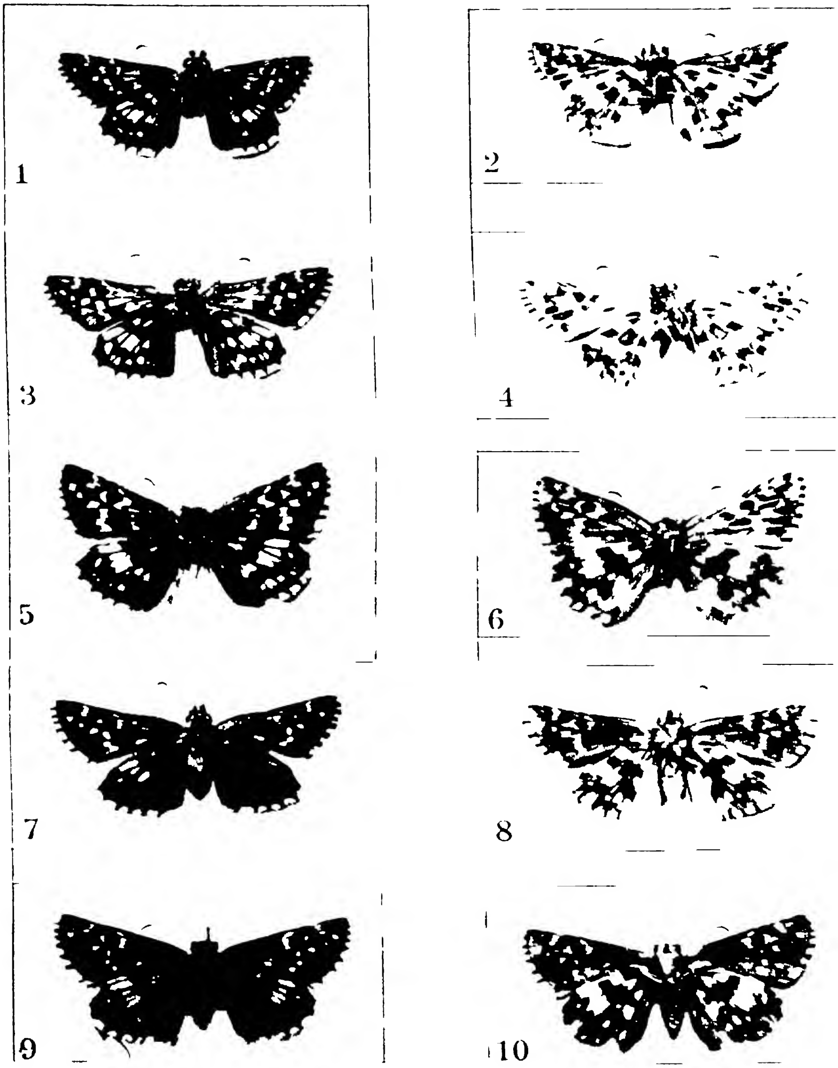
Upperside:—Fore-wings: strongly marked; spots of median row inclined to be squarish; discoidal lunule narrow; discal spot very distinct; basal area of wings in ♂ densely scaled with greyish-white, in a manner suggestive of *foulquieri*. Hind-wings:—♂: all the white markings showing very pronouncedly, the basal spots even being visible. The median band in one specimen is practically without dusky superscaling. In the ♀ the hind-wings are not more strikingly marked than in *alveus*. *Underside*:—Fore-wings: the ground-colour much paler than in *alveus*, yellowish-white or grey, only showing darker spots in one or two places on each side of the median row, and between the discal spot and discoidal lunule. Hind-wings: ground-colour very similar to that of *H. carthami*, very variegated, distinctly mottled lighter and darker, with a fine dark outline to most of the white spots. Inner margin lightish grey. Size, 32–36 mm.

Genitalia. (Pl. XLV, fig. 1.) The genitalia, as will be seen, are very similar to the genitalia of *accreta*. The cuiller is not quite so distended distally, and the apex is even closer to the harpe. The antistyle is hardly hooked at all, and of great breadth. These points, however, vary slightly in the only ♂s that have been available for dissection. The side pieces of the lateral apophyses are of unusual length.

Habitat:—Spain. Widely distributed and by no means confined to Central Spain. Canales (Logrono); Tragacete (Cuenca); Sierra Nevada, Sierra de Alfacar (Andalusia), etc.

Several points in the facies of this subspecies, as well as the likeness in the genitalia to *accreta*, show that the two have originated on similar lines, but some cause has turned *centralhispaniae* in another direction (? mimicry), and this has greatly emphasised certain of its characteristics. At the first glance these specimens will strike one chiefly as being *carthami*. Owing to the want of colouring, this is not quite so conspicuous in the photographs (Pl. XLI) as in nature; still, the extraordinary amount of white on the upperside, especially on the hind-wings, and the almost typical *carthami*-like underside, will be noticed by everyone. The pale ground-colour of the fore-wings, underside, the mottled ground-colour of the hind-wings, the dark outlinings to the white markings and the development of the pointed spots with black centres at the anal angle, all unite to produce the *carthami* effect; while the ♀ specimen (fig. 8) happening to be of the ab. *extensa* form, with a projection from the inner edge of the central spot of the median band, is yet more similar. Added to this, in the localities from which the specimens come, *carthami* is known to occur, and the two species approximate very closely in size. It is remarkable that both steadily increase in size as one goes from north to south in Spain. The photographs on Plate XLI show this plainly. Fig. 1 is from Canales in the north, fig. 3 from Central Spain, and fig. 5 from the south.

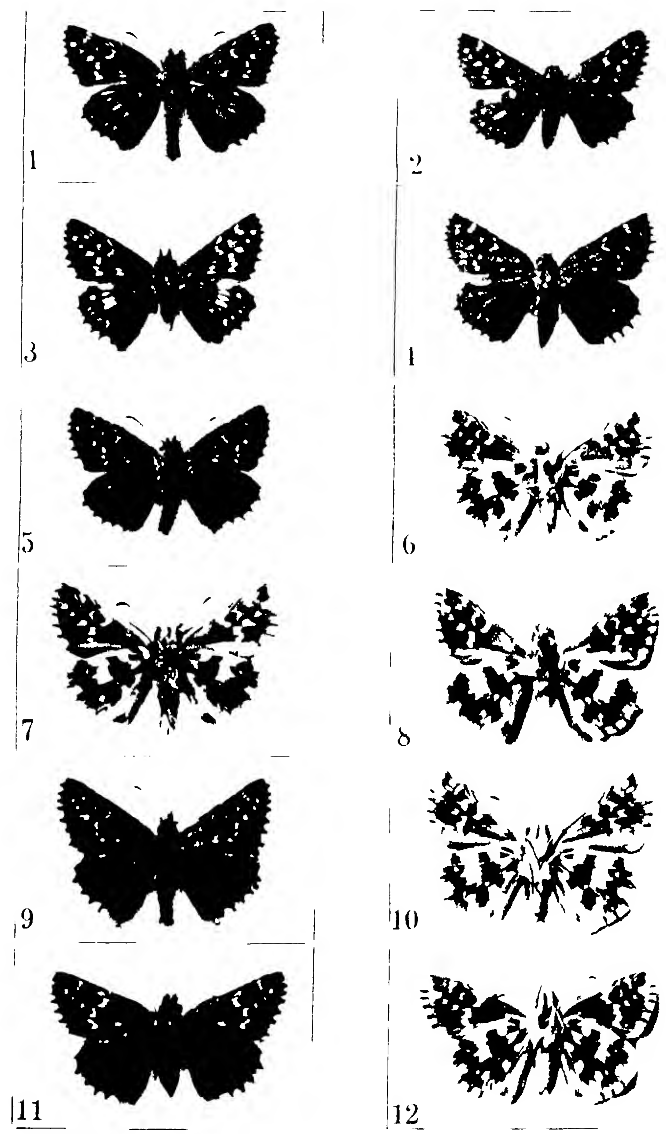
Carthami from northern and central Spain is small, little if any larger than *alveus*, while it is finely developed in the south, where *alveus* also is much larger, though not quite as large as *carthami*. To distinguish between the latter and *centralhispaniae* is no easy matter, and, as usual, especially



Hesperia alveus

Natural size

1 and 2 s-sp *centralhispaniae* Canales, Logroño
3 and 4 " Tragacete
5 and 6 " Sierra de Alfacar
7 and 8 " Canales, Logroño
9 and 10



Hesperia alveus

Natural size

1 3 5 and 7 ♂ s sp *centralitaliae* Massacci di Bolognola

2 4 and 6 ♀ „

8 ♂ *alveus* Rivoli, Nr Turin

9 ♂ race *jurassica* Grand Salève (Haute Savoie

10 „ Eclépens (Vaud)

11 and 12 race *jurassica* Grand Salève Haute Savoie

difficult in the case of the ♀. The experienced collector may be able to make a guess at the identity of *centralhispaniae* by the general look of the specimen, which retains some look of *alveus*, and possibly more of *foulquieri*; but I can only detect two points which offer a fairly reliable means of identifying it. Firstly, the discal spot is set well back from the discoidal lunule at its lower end, as it always is in *alveus*. In fig. 6, Pl. XLI, the separation of these two spots is not as pronounced as usual, but on the upperside of the same specimen it is (see fig. 5). The unusual breadth of the discoidal lunule is of course the cause of this. In *carthami* the discal spot and the discoidal lunule are almost touching at their lower ends. Secondly, there is the typical alvean arrangement of the spots of the median row, spots 4 and 6 separated from 3 and 7 respectively. In most *carthami* these spots are almost or quite touching. Careful observation of these two points should enable most of these remarkable *alveus* to be identified without recourse to dissection.

The character given by Rambur, the colour of the clubs of the antennae, is not reliable in Central Spain, but it may possibly be so in the south. In *alveus* it is usually a light orange, in *carthami* often nearly black; but it can be a blackish-red, or quite orange.

From *serratulae*, which also occurs with it, *centralhispaniae* can be separated by the very mottled ground-colour of the underside of the hindwings, and the plainly visible nervures; and from *foulquieri* by the *carthami*-like features.

Although no very great number of *centralhispaniae* are available, there is not much doubt that it replaces typical *alveus* in Spain.

s.-sp. **centralitaliae,** Vty. (Pl. XLII, figs. 1–7.)

This subspecies is the smallest known subspecies, averaging in size 28–31 mm. Occasional specimens are as large as 34 mm., but they are exceptional. In spite of its small size, the white markings of the upperside of the fore-wings keep on the whole fairly pronounced, while those of the hind-wings vary greatly, especially in the ♂s, which often show a very distinct white median band (see fig. 3), and at other times no more than is normal to typical *alveus*. The band, however, even when most distinct, is narrower than in *alveus*. On the underside the white markings of the fore-wings are as large as, or larger than, in *alveus*, while those of the hind-wings are on the whole narrower. Occasional specimens occur with the median band increased in width, but though this looks very broad and gives the specimen a look of *foulquieri*, it is more owing to the reduced size of the wing itself than to the increase of white, which is still hardly as broad as in typical Swiss *alveus*.

The principal features of the subspecies are: reduced size accompanied by full-sized white markings on the fore-wings, upper and underside; and reduced white markings on the hind-wings, both upper and underside, though frequently less suffused with dark scaling on the upperside. Replaces *alveus* in Central Italy.

Verity notes that certain specimens of *centralitaliae* are very difficult to distinguish from the small form of Italian *foulquieri*, but it seems that it rarely is anything like so heavily scaled with greyish-white on the upperside of the fore-wings as is the latter, and in the majority of cases it should be possible to distinguish it, as one would type *alveus* from large *foulquieri*.

The minor variation of *alveus* is considerable, and very difficult to deal with in any concise manner. Of ordinary varietal races there appear to be two, both fairly well defined, which have already been described; the first is:

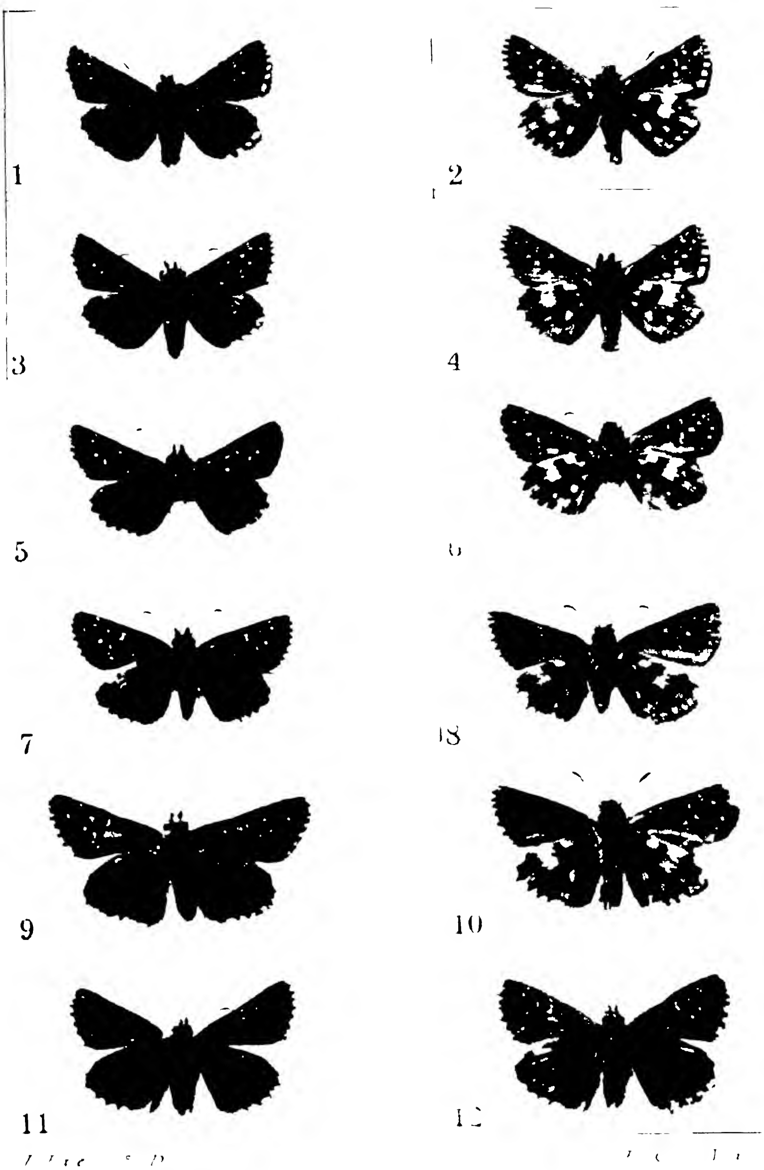
race **ryffelensis,** Obth. (Pl. XLIII, figs. 1–8.)

This is the smallest race of the species. The ♂s 28–29 mm., the ♀s the same, but rarely a little larger, attaining 30 mm.

Upperside :—Uniform dark brown, with the median band and marginal row showing faintly on the hind-wings. The ♀ with a very slight quantity of golden scaling on the basal area of the fore-wings. All the white spots of the fore-wings reduced to the merest points, but still usually all present. The 5th spot of the median row is occasionally lost. *Underside* :—Fore-wings: grey with a slightly washed appearance, the white spots larger than on the upperside, but dull and neither sharply outlined nor contrasting at all strongly with their surroundings. Hind-wings: ground-colour yellowish, median band narrow—much narrower than in small specimens of type *alveus*—reduced in proportion to the size of the specimen, with even edges and the spot between nervures 7 and 8 the same width as the spots adjoining it, or if very slightly broader, extending beyond the others in an outward direction, and not basad.

More confusion exists concerning this beautiful little race than possibly about any other. For this Oberthür himself was largely responsible, for none of the figures he gives can be said to be really typical of *ryffelensis*, and the two ♂s he illustrates on Plate LIV, figs. 470 and 471, in vol. iv of his *Lépidopt. Comp.* are nothing but *alveus* with somewhat small white spots on the upperside. The underside figure especially has no resemblance to *ryffelensis*. Considering this, it was not surprising that collectors began to call any *alveus* with small white spots on the fore-wings *ryffelensis*, and Verity refers to it as the mountain race of *alveus*. This, though correct in one sense, is not so in the general sense, for there is no difference between *alveus* of the plains and those of the Alps, as a whole. *Ryffelensis* is a specialised race of the mountains, but the type form occurs everywhere in the mountains too, and of course numerous varietal forms. The type varies from strongly marked specimens, like those on Plate XXXVII, to very lightly marked ones, with spotting little or no stronger than in *ryffelensis* (see figs. 9–12, Pl. XLIII). All these forms are common at any altitude the species inhabits. The last-mentioned figures (on Pl. XLIII) are not unlike some of those Oberthur gives as *ryffelensis*. If it had not been that Reverdin, in his "Revision of the genus *Hesperia*," had described *ryffelensis* from some of Oberthur's own specimens, I would have disregarded *ryffelensis* altogether, considering it an aberration with small white spots on the fore-wings, an aberration quite unworthy of a name, as it is often difficult to find two specimens with spotting of exactly the same size. *Ryffelensis* is, however, a very distinct race, and is distinguished by the characters of the underside already mentioned, as well as by its diminutive size and the fine white markings on the upperside. To emphasise this, fig. 10 on Plate XLIII was included, to compare with the photographs of the underside of *ryffelensis*. On the upperside of fig. 10 the white spots of the fore-wings are reduced to points, and the specimen is also somewhat undersized. It is, however, still larger than *ryffelensis*, and is distinguished from the latter by the characteristics of the underside: the less suffused and more sharply defined markings of the fore-wings, and the larger white markings of the hind-wings.

On Plate XLIII, figs. 1–4 are photographs of two of Oberthür's own specimens from Larche, which were given to Reverdin, and very kindly lent to me by him especially to illustrate this work. Figs. 5–8 on the same plate are specimens taken by myself in the Grisons, the most easterly locality from which the race has yet been recorded. It is by no means a common form, and has not been



N...

1 and 2 ... Luc...

3 and 4

5 and 6 ... Len...heide ... Grisons

7 and 8

9 ♂ (ab.) L...

10 (ab.) Redu... with typical markings Len...heide

11 (ab.) Pontresina

12 (ab.) Sils ...

found under 5000 ft., but it ascends to well over 7000 ft. It is usually on the wing in late July and early August. Localities : Riffelalp (Zermatt); Larche (Basses Alpes) (Oberthür); Taeschalp (Zermatt); La Vanoise (Savoie) (Reverdin) ; Alp Scharmoin, on the lower slopes of the Parpaner-Rothorn (Grisons) (Warren).

The second is :

race (? s.-sp.) **trebevicensis**, nov. (= **reverdini**, Schawerda *nec* Oberthür).

This race was described by Schawerda from 5 ♂ and 2 ♀ taken at Trebević, Bosnia, and was noted as differing from the type in being slightly larger, with the ground-colour of the upperside lighter brown and not so black as in typical *alveus*, and with the white markings strongly pronounced. The underside has all the white markings broader and the ground-colour of the hind-wings paler yellow. All the wings are said to be a little broader than in the type. I have never seen this race, but Reverdin, who has, states that it is a very striking variety. It was unfortunate that Schawerda selected a name which had already been used by Oberthür for a closely allied species, especially as it seems most probable that *trebevicensis* is a subspecies, though at present one cannot be quite certain.

race **jurassica**, nov. (Pl. XLII, figs. 9-12.)

This race in some ways might be considered a transitional form between *alveus* and the s.-sp. *accreta*. Full size of type, or slightly smaller.

Upperside : -Forewings : broader in proportion to their length than in *alveus*, the outer and inner margins being almost equal in length. The white markings well developed, the spots of the median row tending to become squarer, with the 6th (usually very small) often one of the largest, and more or less square, with its outer edge quite straight. (A character often seen in *centralitaliae*.) Hind-wings : as in the type. *Underside* :– Fore-wings : practically as in the type. Hind-wings : ground-colour somewhat mottled and very bright yellow-orange, but of little density, so that the black scaling underneath shows through strongly, giving the whole a darker, although brilliant, effect. The median band slightly, or considerably narrower than in the type, occasionally as broad; basal spots also reduced in size. Nervures very prominent, outlined in bright yellow-orange. Occurs racially on the Grand Salève and in various localities in the Jura.

The remarkable clearness and prominence of the nervures on the underside of the hind-wings is the most striking feature of this race; owing, however, to the loss of colouring in the photographs, they do not appear at all so prominent as in reality. Fig. 10 gives a fairly good idea of them, especially if it be compared with the forms of the species on Plate XXXVIII. The ♂ shown by fig. 9 has not the 6th spot quite so square as it usually is, but it illustrates the characteristically broader form of the fore-wings very well. One may add that the characteristic prominence of the nervures in *jurassica* usually attains a greater degree of distinctness than do the nervures in *foulquieri* or *armoricanus*. On Plate LII, fig. 8, a specimen is shown from the neighbourhood of Rivoli (nr. Turin). It is a fairly typical specimen, but the nervures on the hind-wings are a little more conspicuous than is usual, and the white spots on the upperside of the fore-wings (not shown) are also somewhat stronger. In these respects it is a little similar to *jurassica*, but it could not be said to belong to that race; it also approaches *centralitaliae*, but is larger than that subspecies. It is an interesting specimen, standing between these two varieties and the type, though nearer to the latter; and is also of interest as

Rivoli is one of the localities where both *alveus* and *foulquieri* occur together. On the upperside this specimen does not bear the least resemblance to *foulquieri*, any more than it does on the underside in spite of its suggestively prominent nervures.

Coming to the purely aberrational forms, the most striking is :

ab. **extensa,** Warr. (Pl. XXXVIII, figs. 7–12.)

The variety in which the inner edge of the central spot is no longer straight, but projects sharply towards the base of the wing.

This aberration, which is not very rare, is on occasions very finely developed. The great interest attaching to it is, of course, the fact that pronounced specimens such as figs. 10 and 11 are almost (or quite) indistinguishable from the African species *numida*. Every conceivable transitional form occurs, and sometimes the development of the projection is not the same on both wings. It occurs in both sexes.

ab. **serratulaeformis,** nov. (Pl. XXXVIII, figs. 4–6.)

Specimens in which the 3rd basal spot on the underside is more or less rounded at its ends and sometimes oval in shape, resembling the corresponding spot in *serratulae*.

This aberration, which occurs in both sexes, can be fairly similar to *serratulae*, but knowing that it exists, it will not be likely that specimens of it will get confused with the latter. The specimens affected, being otherwise typical of *alveus*, have all the other markings in the heavy style peculiar to that species, which one never finds in *serratulae*; also the nervures can be seen quite distinctly against the ground-colour of the hind-wings, underside, which colour is not of the perfectly even density typical of *serratulae*. To this can be added the characteristics of the upperside of both species.

ab. **lineolata,** Rev.

A very rare aberration, in which the first spots of the median row and discoidal series are united, on the upperside, forming a short white line along the inner margin.

Further aberrational variation consists almost entirely of fluctuations in the size of the white spots of the fore-wings, both upper and underside. It is most noticeable on the upperside, specimens occurring which show every possible development of these spots from the merest points, almost invisible, to a size as large as that of the markings in *accreta*, but even when most fully developed they retain the irregular formation which is such a striking feature of the insect. Two specimens of the former extreme are shown on Plate XLIII, figs. 11 and 12. Between these and the type, one must apparently place :

ab. (? race) **scandinavicus,** Strand (= **alticola,** Rebel; **ballotae,** Obth.; **suffusa,** Strand; **serratuloides,** Heinrich).

This aberration is merely *alveus* with very small spots on the upperside of the fore-wings, no other point distinguishing it from the type. It is supposed to be racial in Norway, but judging from our experience of the species in other localities, one cannot but doubt this, for the type form, and very strongly marked specimens, are by no means uncommon in Norway and Sweden. Specimens such as Oberthür figured occur *everywhere* with the type as aberrations. Rebel's types of *alticola* came from the Stelvio Pass, but series from that locality plainly show that such specimens are purely aberrational there also. Strand notes that his types are similar to certain specimens of *alveus* from Bergün, on the Albula Pass. These small aberrations from Bergün are exactly

the same thing as the Stelvio aberrations and Oberthür's figures. It is of course quite impossible to say with any certainty what specimens have the white markings sufficiently reduced to bring them under the name *scandinavicus*.

Strand's aberration *suffusa* is only a further degree of the same form of variation, so is *serratuloides* of Heinrich; it is entirely impossible to maintain the two latter as distinct from *scandinavicus*.

Date of Emergence and Duration of Flight Period.—*Alveus* is a single-brooded species, usually appearing on the wing in July or late June. This applies up to an altitude of about 5000 ft., above which level it emerges a little later, but not much, excepting the race *ryffelensis*, which most usually does not emerge until late July or early August. In the lowlands the flight period may be said to be from late June to late August or early September, and in the Alps from early July to September. In the lowlands single prematurely emerged specimens are occasionally found in May, but this is an extremely rare occurrence, only three authentic cases being known. Numerous records of May *alveus* exist, but these on examination always prove to refer to *armoricanus*. The three cases mentioned are: (1) a ♂ taken at Locarno between the 19th and the 26th of May; (2) a ♂ from the Grand Salève also taken in May by M. Rehfous of Geneva (Reverdin); and (3) a ♀ taken on May 24th at Branson (Valais) (Warren). The occurrence of these three specimens is of course no ground for supposing the species to be double-brooded. The emergence of the species is somewhat extended, so although from early July to the end of the first half of August is the time of greatest abundance of the species, one can find it in decreasing numbers for another month. August records are plentiful, but September ones are few and far between, which probably is owing to the want of collectors more than the absence of the insect; for where specimens are plentiful in late August, as in many parts of the Alps, there is no doubt they could be found in early September too, if they were looked for. Even in such a hot and low-level locality as Follaterre in the Rhone Valley it can often be seen in early September; and there is a beautiful fresh specimen, a ♀, which was taken in the Maderanertal on September 5th, by H. C. Lange, in the Chapman collection. The latest date I have found for the species is September 30th, on the Riederalp (Reverdin).

Distribution.—One of the most widely and universally distributed species of *Hesperia*, found most frequently in alpine and subalpine regions, but occurring plentifully in many lowland localities. Since the discovery of *armoricanus*, it has been frequently said that *alveus* is entirely an alpine species. This of course is not so, and *alveus* often flies on the same ground as *armoricanus*. Its vertical distribution is extensive, as it ranges from little above sea-level in Belgium to over 8000 ft. in the Alps, and quite possibly higher, but the greatest elevation from which I have seen a specimen is just over 8000 ft. This specimen was taken by Chapman on the Bricolla Alp, and is a perfectly typical one.

European localities :—

Austria.—Austria (Reverdin); Stelzing (British Museum coll.); St. Anton; Carinthia (Chapman).

Belgium.—Virton; Wellin (Reverdin).

Bulgaria.—Mt. Vitos; Mus Allah Mts. at Slivnitza and Varnik (Graves coll.).

Czecho-Slovakia.—(No records, but the species must certainly occur there, approaching the frontiers as it does in several localities.)

France.—La Preste; Abriès; St. Martin de Vésubie; Luchon; Brignole; Gèdre; Cauteret (Reverdin); Larche; Lauteret; Grand Salève (Reverdin, Chapman); Gavarine (Warren, Chapman); Bobbie; Bourg St. Maurice; La Grave; Barcelonette; Allos;

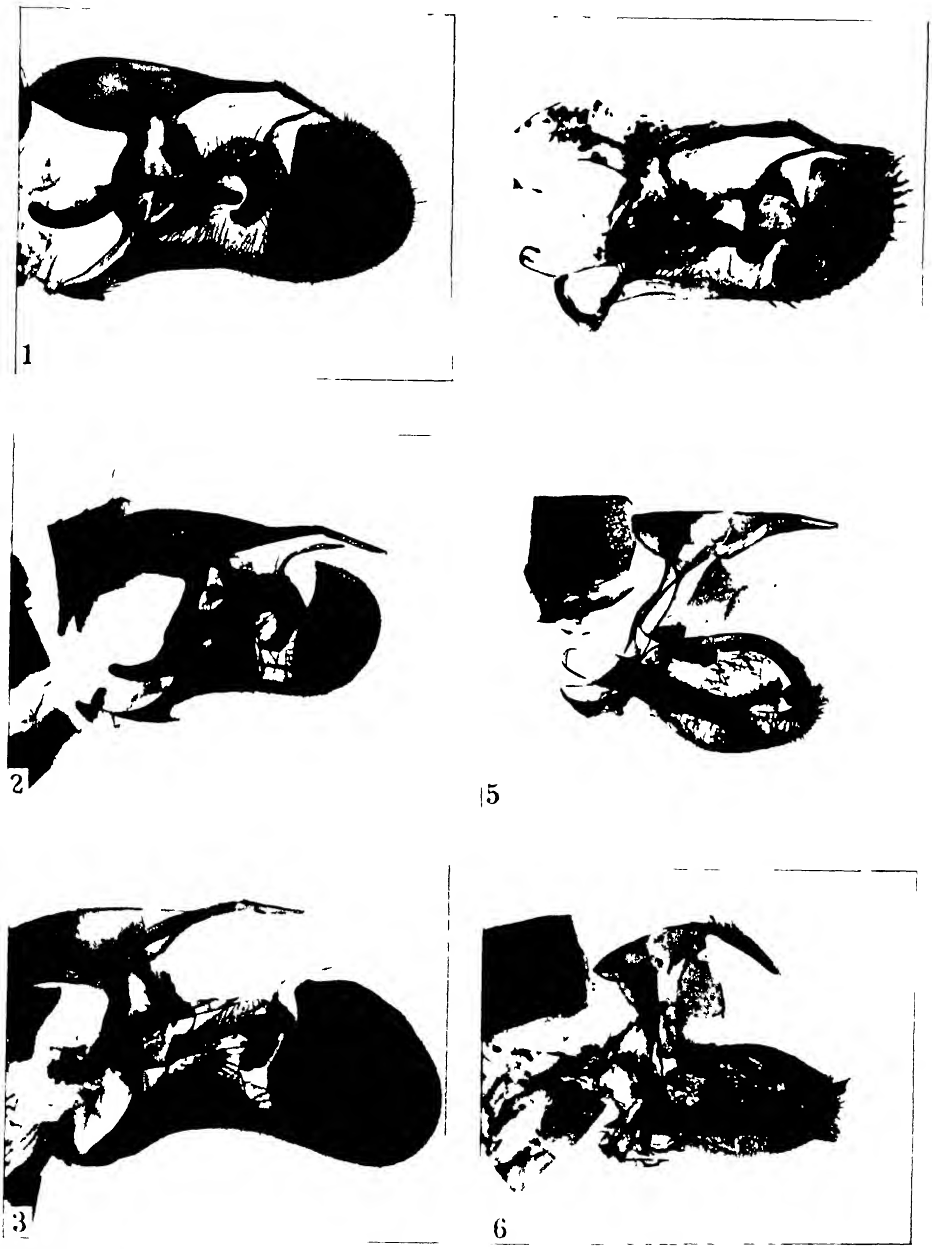
Le Chapeau; Burgnasco; Mt. Brévent (Chapman); St. Maurice-sur-Moselle (Gibbs); Pralognan (Tring Museum coll.).
Germany.—Dresden; Lauritz; Regensburg (Reverdin); Stettin; Kreuznach (British Museum coll.); Germany (Chapman coll.).
Hungary.—Hungary (Reverdin).
Italy.—Botzen; Stelvio Pass; Bardinato; Alassio (Reverdin); Oberbotzen; Assisi; Palena (Wheeler); Pre St. Didier; Cogne; Courmayeur; Falzarego Pass (Chapman); Mendel Pass (British Museum coll., Chapman); Alp Veglia; Brunate; Cruzo Bianca; Fenestrelle; Asserci; Bolognole and Serroni dell' Efra in the Sibillini Mts. (Verity); Rivoli, nr. Turin (Chapman coll.).
Jugoslavia.—Carniola: Wippach. Bosnia: Maklen Pass; Trebević. Herzegovina: Gaeko (Reverdin).
Norway.—Gudbrandsdal; Sundalen (British Museum coll.); Dovre (Oberthür).
Rumania.—Herkulesfurdö (Chapman coll., Tring Museum coll.).
Russia.—Esthonia; Ural Mts.; Caucasus (Reverdin).
Spain.—Catalogna; Sierra de Alfacar (Reverdin); Canales (Logrono); Tragacete (Chapman); Sierra Nevada (Rambur); Vall de Nuria; Guardiola-Bagá; Setcases; Mountains above Atmetlla (Sagarra).
Sweden.—Sweden (British Museum coll.).
Switzerland.—Bergelltal; Stalla; Maloja; Locarno; Calanda; Parpan; Julier Pass; Bernina Pass; Riederalp; Chandolin (Reverdin); Zinal (Reverdin, Wheeler); Saas Fée; Ferpècle; Dischma Tal; Davos; Evoléne; Klosters; Guarda; Val d'Hérens; St. Gotthard; Goeschenen; Hospental; Vissoye; Almagell; Bricolla Alp; Fluela Pass; Lavin; Maderaner Tal; Val Piora (Chapman); Zermatt (Chapman, Warren, etc.); Simplon Pass, summit (Sheldon); Bérisal; Laquin Tal (Wheeler, Sheldon); Heutal (Wheeler); Kandersteg; Gemmi Pass; Caux; Verossaz; Tanay; Aigle; Sépey; Vernayaz; Follaterre; Branson; Eclépens; Gondo Gorge; Campolungo Pass; Fusio; Solis; Lenzerheide; Bergün; Preda; Zernez; Ofen Pass; Tschitta Pass; Fiesch; Binn; Albrun Pass; Saflischtal (Warren).

Hesperia armoricanus, Oberthür. (Pl. XLVI.)

Identification.—*Genitalia.* (Pl. XLIV, fig. 2.) The uncus long and slender. The lateral apophyses roughly triangular, and their distal margins convex, the whole apophysis being shorter than in *alveus.* The cuiller is smaller than in any other species of the group; in outline very regular, its greatest breadth but little more than half its greatest vertical measurement. The free portion of the proximal edge, from the point of junction with the stylifer to the apex, slopes backwards away from the harpe. The apex is sharply pointed, and forms the actual summit of the cuiller. It is raised considerably above the dorsal ridge of the harpe. The style is short, but a little wider than in *alveus*, and is curved more than bent, as in the latter. The antistyle narrow, and its terminal hook slender and sharply pointed.

The chief points of distinction between *armoricanus* and *alveus* and *foulquieri* are, of course, the reduced proportions of the cuiller, and its very sharp apical termination. Also the convex distal margins of the lateral apophyses; all very easily observed features.

General features.—Size, 24–30 mm., exceptionally 32 or even 34 mm. *Upperside* :—Fore-wings: discoidal series incomplete, 3rd spot wanting; median row complete, spot 6 well separated from 7, and 5 often nearer 6 than 4; outer row wanting; discal spot present, narrow and more or less indistinct; one or two subcostal spots present, the 1st over the discoidal lunule, the 2nd slightly to the outside of the lunule. Hind-wings: basal spots occasionally faintly visible; median band complete or incomplete, showing fairly clearly, being only slightly suffused with darker scaling; marginal row present, composed of distinct, but small and well-separated spots. *Underside* :—Fore-wings: ground-colour greyish, with darker patches showing here and there, the space between the discoidal lunule and the discal spot usually conspicuously dark, often appearing as a quite black spot. The discal spot very narrow and sharply defined; median row complete. Hind-



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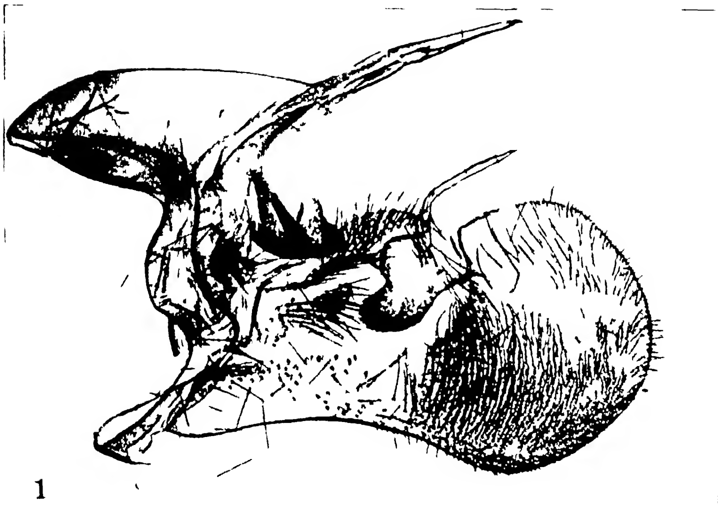
Photos J. Julien

Genus *Hesperia* and genus *Powellia*, male armatures

1. *H alveus*	4 *H cinaræ*
2. *H armoricanus*	5 *P sertorius*
3. *H foulquieri*	6 *P orbifer*



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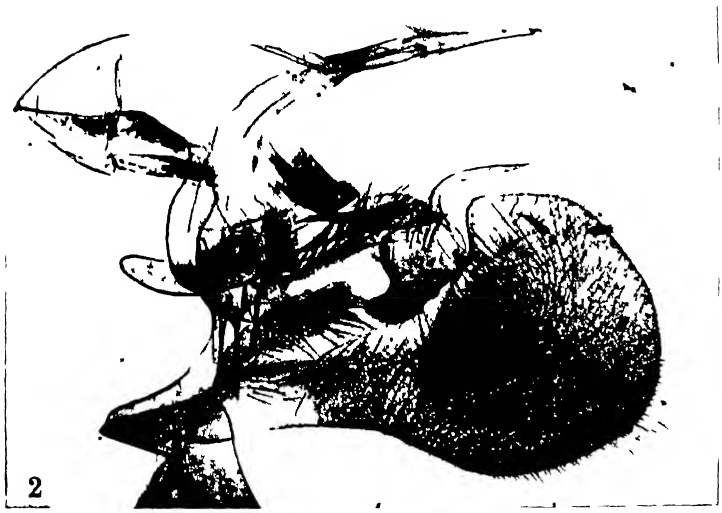

2

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Genus *Hesperia* male armatures

1. *H. alveus* s-sp. *centralhispaniae* × 25
2. *H. alveus* s-sp. *accreta* × 25

wings: basal spots present; median band complete or incomplete, more often the former, though spots 2 and 3 are always small, inner edge of central spot straight; marginal row composed of five spots of variable size; ground-colour yellowish, varying to brownish-orange. Nervures very distinctly marked.

COMPARISON WITH THE OTHER SPECIES OF THE GROUP.—As the characters which distinguish *alveus* from *amoricanus* have already been given in connection with the former, we need now only briefly mention the features which are distinctive of *armoricanus*, and which distinguish it from *alveus*. They are: small size in connection with the heavy white markings on the upperside, fore- and hind-wings; the median band though showing very clearly is much narrower than in *alveus*, and the spots of the marginal row are distinct, but small and more or less rounded, and not elongated or wedge-shaped. Underside: greater part of the fore-wings suffused with grey, adding to the striking appearance of the dark spot between the discoidal lunule and the discal spot. On the hind-wings, the bright brownish-orange ground-colour, common in the ♀, rarer in the ♂, is never seen in *alveus*; also the narrow median band and very pronounced nervures.

From *foulquieri* there is little or no difficulty in distinguishing *armoricanus*; in addition to the characters mentioned above, the very narrow and sharply defined discal spot on the underside further distinguishes *armoricanus*.

COMPARISON WITH OTHER APPROXIMATING SPECIES OF THE GENUS.—There is only one species outside the group which on occasions somewhat resembles *armoricanus*, namely, *onopordi*. This has been dealt with already (see *onopordi*), but the following distinctive features of *armoricanus* may be usefully contrasted with those previously mentioned for *onopordi*.

Armoricanus is best distinguished by the appearance of the spots of the marginal row on the upperside, viz. small, somewhat round, well-defined and separated, as opposed to the hazy outline, greater size, and strong tendency to run together, in *onopordi*. On the underside, by the sharply defined and narrow discal spot; the small size of the spots of the median band between nervures 2 and 4, well separated from each other and from the spots on each side of them; the prominence and light colour of the nervures, and the absence of black outlining to any of the spots.

The aberration of *armoricanus*, in which there is a projection from the inner edge of the central spot of the median band, is never very similar to *onopordi*, though it would seem that it might be so. The projection, however, assumes a variety of forms, and when really pronounced, and not merely an indication just breaking the typical straight edge, is never sharp and narrow as in *onopordi*, but broad and blunt. Owing to the very constant form of this spot in *onopordi*, such specimens do not strike the eye as being in the least similar to the latter.

SEXUAL DIMORPHISM.—There is considerable difference between the sexes in this species. The ♂ is a good deal more strongly marked with white on the upperside, especially on the hind-wings, though the spots of the fore-wings too are usually larger than in the ♀; also there is but little superscaling in the ♂, while in the ♀ the whole of the fore-wing is thickly covered with golden scales often with a green tinge, and not infrequently the median band and marginal row of spots on the hind-wings bear the same. On the underside the ♀ usually has the ground-colour of the hind-wings brighter than it is in the ♂,

and often of a much deeper shade too. The ♂ has, and the ♀ has not, a costal fold on the fore-wings.

VARIATION.—The variation of *armoricanus* is very limited. Oberthür's name, "*fabressei*," was the result of an error, the specimens so named being *fritillum* and not *armoricanus*. Oberthür referred to this in a later volume of his great work, and noted that his specimens from the Sierre Alta (? should this have been Serre Alta, and did the specimens really come from Portugal and not from Spain) were probably *fritillum* and not *armoricanus*, which of course his figures of them suggest.

The only racial variety of the species which has been described is rather a curious one, the distinguishing characters being anatomical and not superficial.

race **persica**, Rev.

In this race the genitalia differ from *armoricanus* in the following manner: the apex of the cuiller instead of being sharply pointed is rounded off; this difference sounds very insignificant, but it alters the look of the cuiller very considerably. Otherwise *persica* is practically indistinguishable from *armoricanus*. It flies in Asia Minor and Greece, as does *armoricanus*.

As in the case of *onopordi*, Verity has applied a separate name to the specimens of the second brood of *armoricanus* in Central Italy. These specimens, however, do not constitute a true seasonal form, as only a certain proportion of the brood is affected.

race **fulvoinspersa**, Vty.

Verity describes the race as follows: "The great majority of individuals of the second brood (August and September) differ from those of the first by having the whole of the wings tinged yellow-fulvous, so that the dark pattern is brownish and the light spaces yellowish."

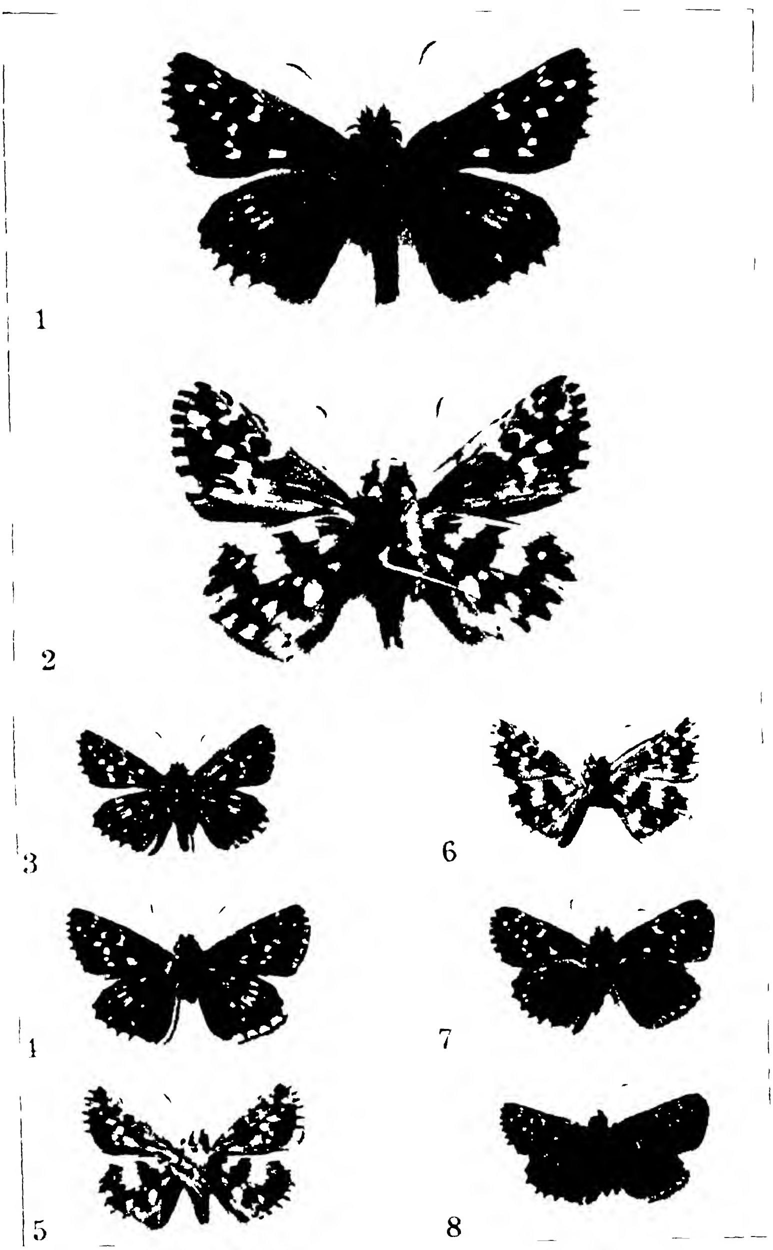
For reasons given before (see under *onopordi*), it was evident that the "tinged with yellow-fulvous" refers to the underside. Speaking roughly, it may be said that there is a tendency to produce a darker shade of colouring on the underside in the second brood, but this tendency is by no means confined to that brood. Some undoubted first-brood specimens have just as dark an underside as any of the second brood. I have two second-brood ♀s from Florence, which show exactly the same colour as a ♀ taken by Querci in the Aurunci Mts. in June. In Swiss specimens deeply-coloured examples occur in both broods, more frequently in the second brood. On the whole, Corsican specimens seem to show the strongest contrast between the broods, and perhaps might merit a special name more than the continental specimens do, but all the same, they cannot be considered a true seasonal form, for they unquestionably do not anything like entirely replace the paler specimens.

In the minor varieties there is not much to record. Only one or two aberrations seem to have received names.

ab. **onopordiformis**, Vty.

The only description given with this name was: "specimens very similar to *onopordi*, such as that figured by Oberthür, vol. iv of the *Et. Lép. Comp.* (figs. 509–510), occur also in Tuscany, but are very rare; they well deserve the name of *onopordiformis*, mihi."

The practice of giving names to figures published by other authors is not a commendable one. Presumably the original author, who had the actual specimen under his eyes, would have given it a name had it merited one. But



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Hesperia armoricanus.

1. Upperside, × 2. 2. Underside, × 2.

Natural size.

3. Branson (Valais). 6. Algiers.
4. Bordighera (July). 7. Corsica.
5. Branson (Valais) (May). 8. Branuelas (July).

apart from this, this method of naming causes endless trouble to the reader, who, before the description can convey anything to him, has to refer to some other work. Most entomologists are not so fortunate as to own a copy of Oberthür's great work, and many live out of reach of libraries where they can see one. In this case, even with Oberthür's figures, the want of a few words of description leaves considerable doubt as to what the name represents, for the two figures are not identical, and approach *onopordi* in more than one respect. The necessary information was supplied by Querci, who has the fullest knowledge of all Verity's work. In notes accompanying a consignment of Hesperids to a client he states: " *armoricanus* ab. *onopordiformis*, Verity . . . in these 3 ♂s the ' Blachier's sign ' is as in *onopordi*." That is all, but it suffices. The character called the " signe de Blachier " by Reverdin, is the 1st spot of the median band, underside, in *onopordi*, so we may take it that the diagnosis of this aberration should be : specimens in which the 1st spot of the median band, underside, is similar in form to the corresponding spot in *onopordi*.

There is often a tendency to this variation, affecting the inner or outer edge of the spot, but the extreme is decidedly rare.

ab. **enervata,** Vty.

Specimens thickly covered with light grey scaling on the upperside and white on the underside, giving them a very white appearance both above and below.

ab. **extensa,** Warr.

Specimens with the inner edge of the central spot of the median band, underside, developing a sharp projection towards the base of the wing.

One other form of variation may be mentioned, *i.e.* size. Occasionally very large specimens are found in the first brood. These specimens sometimes attain a size of 34 mm., but more often do not exceed 32 mm. Such specimens naturally have a great look of *alveus*, but in Switzerland at any rate they do not occur in the summer brood when *alveus* is on the wing. I have seen these large examples from France (June), Corsica (July), and Bordighera (July), which suggests that the first brood can still exist in those months. Two of these large specimens are shown on Plate XLVI, figs. 4 and 5, and a normal-sized one at fig. 3.

Date of Emergence and Duration of Flight Period.—The time of emergence and the duration of the flight periods of *armoricanus* are subjects on which there seems to be a good deal of conflicting opinion. The available data are not all that could be desired, and careful notes taken throughout an entire season in some southern locality would be of the greatest interest and value. In Switzerland and western France the species is double-brooded, quite clearly and in a manner which leaves no room for doubt, the first brood emerging in early May and lasting about three weeks, the second not beginning until about the middle of August, and lasting to late September. Eggs obtained by Powell in Brittany from the summer brood ♀s produced hibernating larvae. The interval between the two broods in Switzerland is a clear ten weeks, and German records give a similar result.

On coming to the Mediterranean zone we find a very different state of affairs. From various southern localities I have reliable records covering a period of eight months, *i.e.* February 21st to October 21st. There are also records of the insect in every month between these dates. Unfortunately, however, nearly all records refer to single occasions in different years, so that they give one very little to work on. Querci alone has made some consecutive

observations on the subject, in the Camaione Valley (Lucca) and in the neighbourhood of Florence. From the former locality he records three broods: the first ending June 8th; the second from July 1st to the 18th; the third from August 18th. From the Florence neighbourhood four broods: the first variable according to the season; 1915 June 1st–10th, 1917 May 13th–June 13th, 1920 April 28th–May 22nd, 1921 May 7th–June 9th. The second brood he states he has never seen, and does not know if it occurs; the third from early August to the end of September; the fourth brood October 12th–21st. The latter not occurring every year. These dates are very valuable, but one cannot but question the soundness of the conclusions Querci draws from them. It will be seen that the first brood at Florence can cover a period of nearly two months, according to the season, *i.e.* April 28th- June 13th. The greatest duration of time for any one year is just over one month, but it must be noted that in 1917 he only records it as ten days. That of course merely refers to the time he devoted to collecting. From our knowledge of the habits of the species, it is safe to conclude that a few specimens of the insect could probably be taken in the Florence district from late April to mid-June every year, though the early and late specimens will always require careful looking for. This being so, we could have eggs from the first brood laid at intervals with seven weeks between the first and the last, which would seem to be sufficient to account for a protracted second brood from late July to September. Querci notes that the Camaione Valley is very cold in the spring, and that all Lepidoptera emerge there later than in the Florence neighbourhood, but his collecting seems never to begin in the former locality before June. If the first brood was over by June 8th, it certainly had emerged by the middle of May. We know that even in such a hot locality as the Rhone Valley, between Martigny and Brig, there is a lapse of at least ten, and more often eleven, weeks between the broods, *i.e.* between the disappearance of one and the beginning of the other. This means that the first laid eggs of the first brood do not mature until eleven weeks after the disappearance of the last specimen of the first brood, which must be at least two (and very likely more) weeks after those eggs were laid. This gives a period of thirteen weeks as necessary for the egg, larval and pupal stages of the insect, under climatic conditions very similar to those prevailing in northern Italy. It is therefore obvious, even allowing for a certain accelera-tion owing to a possibly milder climate, that specimens emerging on July 1st could not have developed from eggs laid on, say, May 15th. The Camaione Valley specimens of early July must therefore still belong to the first brood (the occurrence of occasional very large specimens with the normal-sized ones in July has already been mentioned as suggestive that the July specimens belong to the first brood, as these exceptional specimens are a marked feature of the first brood in northern localities),* while those recorded as appearing on August 18th, must be the beginning of the true second brood. Considering these facts, it might be thought doubtful if the Florentine specimens taken on October 12th could be the progeny of mid-August specimens, a lapse of only some eight weeks instead of thirteen. Powell's observations on the life-history of *onopordi*, show that the individuals of the third brood mature considerably quicker than those of the second; it is therefore probable that the same is the case with *armoricanus* and that a partial third brood takes place on favourable occasions; it is of course only a third brood, and absolutely impossible that it could be a fourth.

Subsequently to Querci's observations, Verity, writing in the *Entomologist's*

* See Note (3), p. 161.

Record, accepts the theory of four broods. Thus he considers the Camaione Valley records give three broods, and assumes the fourth to occur because October specimens have been taken at Florence. For Florentine records he takes as second brood a few " sporadic individuals in June " taken in the Pian di Mugnone, the third brood emerging in early August lasting to September, and, on favourable years, a partial brood in October. This does not at all agree with Querci's record of the first brood in the neighbourhood of Florence, from early May to early June. Even supposing it was confined to May, are we seriously asked to accept a few June specimens as a second brood? He also records specimens taken at 1600 ft. on Mt. Conca from July 5th–August 10th, as second brood. One interesting point about these dates apparently is, that where the July specimens occur, the October ones *do not*, and vice versa. In the Florence district there are only two regular broods, and a partial third one (counting the October specimens as such), and we are asked to call the second of these broods the third, because specimens occur at an intermediate date elsewhere. As further evidence, the July and August specimens of Mt. Conca are brought forward as second brood; but we are given no data as to the other emergences on Mt. Conca. This, however, is probably correct as the altitude is not great enough to enforce single-broodedness, and one cannot suppose that the first brood could last until August; we also know that the species can occur early enough, in suitable conditions, to produce a second brood in July; though this was not so in the case of the Camaione Valley. We therefore have the so-called second brood (which is said to be distinguishable from the individuals of the first and third broods), in one case composed of the true second brood and in the other of the first brood; an eloquent testimony to the fact that *armoricanus* does not develop any real seasonal variation.

In Italy, therefore, it seems that *armoricanus* is double-brooded, as everywhere else in Europe, with a partial third brood. In those localities where the first brood emerges in February and March, it seems possible that there may be three regular broods, but on the other hand it is also possible that these early specimens are similar to the late October ones, and were well advanced in the autumn but failed to emerge the previous year, and so appeared unusually early in the spring. Unfortunately we have scarcely any records of other dates from these localities. There are, in the British Museum collection, specimens from the district north of Salonika labelled, February 21st, 1916; May 9th, 1917, and August 7th, 1917. This does not help one much, though the May and August 1917 look very like the ordinary two broods.

Reverdin records a specimen from Hyères on March 5th, 1893; Sheldon one on May 18th, 1905; Chapman specimens from the 10th-16th of July in Central Spain. I have received specimens from Vigo taken September 15th by E. A. Cockayne, which shows that the second brood is of normal duration in Spain, as all the specimens were slightly worn. Are Chapman's July specimens first or second brood? We know nothing of what preceded them to help us in forming an answer, but the latter seems the most probable in such a locality, in which case, if there is not a regular third brood, one might expect very early spring specimens.*

From France, May–June and August–September are the most frequent dates, but April records are very unusual, and Reverdin's March specimen is quite unique.

Distribution.—The species is widely distributed in the western Palae-

* See Note (4), p. 162.

arctic area, ranging from north Germany to Algeria, and from Belgium to eastern Russia, Greece and Asia Minor. It is essentially a lowland species and does not usually rise to much above 3000 ft.

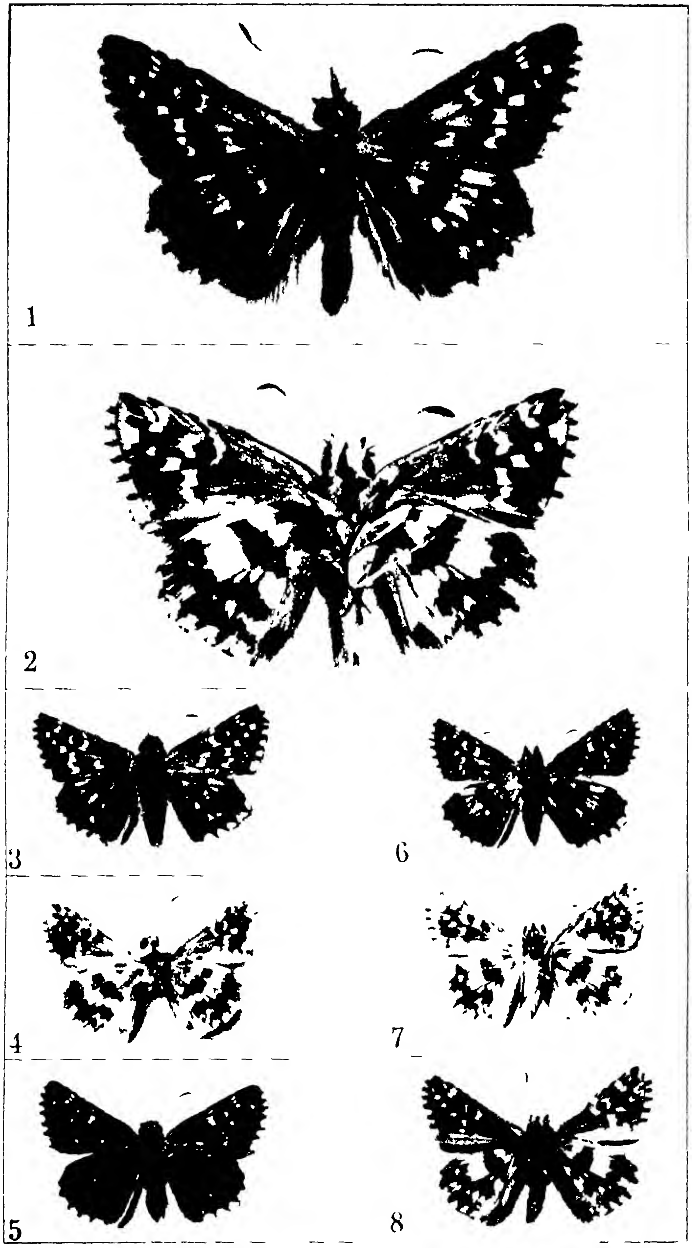
European localities :—

Austria.—Hütteldorf; Neuhaus; Mödling; Hainburg; Tauerling (Reverdin).
Belgium.—Ostend (Reverdin).
Bulgaria.—Slivno (Graves coll.).
France.—Neyron; Forêt de Vouvans; St. Zacharie; Cortamboeuf; Folard; Dompierre-sur-mer; La Guimarais; Angoulême; Pardigon; Digne; Perpignan; Mt. Ventaux (Reverdin); Hyères (Reverdin, Sheldon); Florac; Rennes; Cancale (Oberthür); Plouharnel (Wheeler); Valescure; La Foux (British Museum coll.); Vernet-les-Bains (Gibbs); Marseilles (Tring Museum coll.); Argelés (Cooke).
Corsica: Bastilica (Chapman coll.); Tattone (2500 ft.); Luri; Ajaccio (Gibbs); Corte (Warren); Col de Vizzavona (3850 ft.) (Powell, Wheeler).
Germany.—Dresden (Reverdin); Meseritz (British Museum coll.).
Greece.—Sueva, N. of Salonika; Kopriva; Struma Valley (British Museum coll.).
Hungary.—Hungary (Reverdin); Földvar (Tring Museum coll.).
Italy.—Bordighera (Temperley); Mt. Albani; Görz (Reverdin); Subiaco; Assisi; Oberbozen (Wheeler); Colombaro; Galliera; Lesignano; Modena; Piteglio; Pertusola; Casciana; Florence; Sibillini Mts.; Gran Sasso; Oricola; Formia; Vallegrande; Mainarda; Mt. Meta; Aurunci Mts.; Aspromonte (Verity); Camaione Valley; Valley of the Mollarino (Querci); Susa (Chapman).
Jugoslavia.—Carniola: Wippach; Laibach (Reverdin).
Croatia: Agram (Reverdin); Zengg (Tring Museum coll.).
Bosnia: Jajci (Gibbs).
Herzegovina: Herzegovina (Reverdin).
Rumania.—Hermanstadt (Reverdin); Flamanda (Reverdin, Tring Museum coll.); Bihar; Mezöseg (Tring Museum coll.).
Russia.—Odessa (Reverdin); Sarepta; Novorossisk (Sheldon).
Spain.—Sierra de Alfacar; Granada (Reverdin); Branuelas (Chapman); Vigo (Cockayne); Serra de Berti; Moncada; St. Pere de Vilamajor; Sta. Coloma de Gramanet; Prat del Llobregat (Sagarra).
Switzerland.—Brig (British Museum coll.); Versoix; Prégny; Hermance; Tramelan; Siallon (Reverdin); Locarno (Reverdin, Chapman); Follaterre; Branson; St. Triphon; Gunten (Warren).
Turkey.—Turkey (Chapman coll.); Constantinople (Reverdin, Graves).

Hesperia foulquieri, Oberthür. (Pl. XLVII.)

Identification.—*Genitalia.* (Pl. XLIV, fig. 3.) The uncus long and slender, as in the last two species. The lateral apophyses triangular in form, with their distal margins slightly concave, and the stem which supports them very slender and long. The cuiller is more developed than in any other species, its ventral and distal aspects are greatly distended, which gives the outline of the process a very irregular appearance, inclining to be more oval than circular. Its greatest horizontal measurement is just equal to its greatest vertical measurement. The apex is blunt, usually standing well above the harpe; the free portion of the proximal edge is never really a straight line, and slopes forwards towards the harpe. The stylifer contracted, antistyle short, narrow, and terminates bluntly, directed downwards, not hooked. (On rare occasions there is a slight hook.)

The remarkable form and dimensions of the cuiller distinguish *foulquieri* from all other species, so that anatomically there is never the least trouble in identifying it. The formation of the lateral apophyses is equally distinctive, but requires much greater magnification to be readily observable. Their long slender stem and short body are very different from the corresponding structures in *alveus* or *armoricanus*, and in the event of a specimen in which the cuiller was malformed being examined, they offer the surest means of identification. The characteristic formation of the apex of the cuiller can, as we have seen, be almost exactly reproduced in *alveus*, but in such cases it is seldom so much raised above the harpe as it normally is in



J. Bale, S & D. Ltd   Photos. J. C. S. Hanson

Hesperia foulquieri

1 Upperside, × 2. ♂   2. Underside × 2. ♂

Natural size

3 ♂ Digne
4 ♂ ,,
5 ♀ St Zacharie (Taken by G Foulquier.)
6 ♀ race *picena* Monti Sibilini
7 ♀ ,, ,, ,, ,,
8 ♂ s-sp *bellieri* Larche

foulquieri. Finally, the antistyle, although a little variable, is a very distinctive feature of the species.

General features.—Size, 30–34 mm. *Upperside:*—Fore-wings: broad, outer margins almost, or quite, straight from nervure 6 downwards. Discoidal series incomplete, 3rd spot always, 2nd often, wanting; the discoidal lunule broad, with moderately straight edges, often shaped somewhat like a capital I; median row complete, composed of fairly equal-sized square spots; outer row wanting; discal spot distinct, broad, and not sharply outlined; one subcostal spot present, situated over the discoidal lunule; ground-colour variegated, owing to a considerable quantity of white scaling being mingled with the dark, especially in the basal, central and outer marginal areas. Hind-wings: basal spots visible, often as clear as the median band, which is complete, and but little obscured by dark scaling; marginal row present, composed of more or less united spots with no defined edges. *Underside:*—Fore-wings: basal area light coloured, discoidal lunule, median row and discal spot, all pronounced, the latter being broad, often broader than the discoidal lunule. Hind-wings: basal spots large, forming an almost straight row, the 3rd squarish; median band complete, inner edge of central spot straight; marginal row poorly developed, two spots next the anal angle and one between nervures 4 and 6, which is united to the margin, being the only distinct ones. Ground-colour brownish-yellow of uniform density; nervures visible, but not very pronounced.

Comparison with the other Species of the Group.—So much was said of this species in connection with *alveus* that it is unnecessary to refer further to the latter here. A few points which distinguish *foulquieri* from *amoricanus* may, however, be useful. The size of the two species is of course always noticeably different, as is the form of the fore-wings also. The ♂s of *foulquieri* further differ from *amoricanus* on the upperside by the very variegated appearance of the ground-colour; the broad square spots of the median row; the heavier discoidal lunule; the broad discal spot; the large basal spots; the complete median band, and the broad almost united spots of the marginal row. The ♀s differ by the same characters, though they are often less pronounced, but some of them are present in most cases. On the underside, both sexes of *foulquieri* can be distinguished by the broad soft-edged discal spot and the (usually) light-coloured inner margins of the hind-wings.

Comparison with other Approximating Species of the Genus.—There is only one species outside the group which can be said to be to any real extent similar to *foulquieri*, and the latter does not vary in a manner which produces a likeness to any of the other species; the species first alluded to is *cinarae.* The similarity between the latter and *foulquieri* is, in point of fact, more apparent than real. A moment's comparison of the photographs on Plates XLVII and XLVIII will enable anyone to distinguish the two. The great development of the white markings on the upperside of *cinarae*, the complete discoidal series, and series of subcostal spots, etc., are characters which could not be mistaken for those of *foulquieri.*

Sexual Dimorphism.—The ground-colour of the upperside is the same in both sexes, but a little less variegated in the ♀, which has the fore-wings suffused all over with yellowish-green in an even manner, so that the ground-colour is not left exposed in certain areas as in the ♂. Even when this superscaling is very thin, it still covers the whole area of the wings, excepting the immediate surroundings of the white spots. The median band and marginal row are often more obscured in the ♀, but they can be quite as distinct as in the ♂ in some

specimens. On the fore-wings, however, the white spots are invariably smaller in the ♀, and frequently tend to become obsolete. The ♂ with, the ♀ without, a costal fold on the fore-wings.

VARIATION.—*Foulquieri* is not a variable species, and so far as the minor forms of variation are concerned, it may be considered a very constant species. Two subspecies, however, have already been described, one of which (*bellieri*) was regarded as a distinct species by the describer. Subsequent experience, however, shows that the claim cannot be substantiated, though the subspecies is a very interesting one.

s.-sp. (and race) **bellieri,** Obth. (Pl. XLVII, fig. 8.)

In this subspecies there is a great increase of white on the upperside of the fore-wings in the ♂, the basal area up to the discoidal lunule being distinctly white; while on the hind-wings of both sexes the median band and marginal row of spots are much less suffused with dark scales, showing very much more clearly, and being also decidedly broader. On the underside, the basal area of the fore-wings of both sexes is much paler (practically white in the ♂), and the median band is extremely broad; the ground-colour of the hind-wings being also lighter. The great breadth of the median band is very noticeable in the photograph (fig. 8).

Habitats:—Larche, Basses Alpes, where it occurs to the exclusion of *foulquieri* (Oberthür, etc.); St. Martin de Vésubie and Beauvezer in France (Reverdin); Pescocostanzo (Abruzzi) (Reverdin, Verity); and in the Sibillini Mts. (Verity); in Italy. In the last four localities, however, it occurs with *foulquieri*, and in the Sibillini Mts. Verity records frequent transitional forms, in which the upperside appears to be *bellieri*, but the underside is *foulquieri*.

The occurrence of these specimens, and the want of any anatomical difference between *foulquieri* and *bellieri*, shows that the latter cannot be maintained as a distinct species, and in consequence, in the localities where the two occur together, *bellieri* can only be held to constitute a race.

race **picena,** Vty. (Pl. XLVII, figs. 6 and 7.)

This race (which is not far removed from becoming a subspecies) occurs in the Sibillini Mts. It is described as being a frailer and smaller insect, having narrower wings, duller in colour, more suffused with grey on the fore-wings, and with broader white markings on the hind-wings. These points can be clearly seen in figs. 6 and 7, and contrasted with the type ♀, fig. 5. A still smaller race occurs on Mt. Ventoux in France, but of ordinary facies.

Picena is an interesting race, because absolutely typical *foulquieri* occurs in N. Italy, near Turin, and at Valdieri. *Picena* is the first step towards *bellieri*, and with it fly those transitional specimens which we have already referred to (which are practically *foulquieri*), and which have been named:

ab. **supra-bellieri,** Vty.

This aberration was described as being almost or quite similar to *bellieri* on the upperside and to *foulquieri* on the underside.

The association of these forms is of the greatest interest, and shows us a very remarkable series of stages in the evolution of *bellieri*. First we have true *foulquieri* of southern France and northern Italy, then *picena* of the Sibillini Mts., which develops *supra-bellieri* passing to race *bellieri* in the same locality, and finally the subspecies *bellieri* of Larche.

ab. extensa, Warr.

The form in which the central spot of the median band on the underside projects towards the base of the wing, instead of being straight.

This aberration is not common in *foulquieri*, but is, nevertheless, occasionally strongly developed; it occurs in *bellieri* also. The only other aberrational tendency worth mentioning affects the size of the spots of the median row. These on occasion are a good deal reduced, and some even wanting, though this is almost confined to the ♀s.

DATE OF EMERGENCE AND DURATION OF FLIGHT PERIOD.—*Foulquieri* is a single-brooded species, occurring from late June to late August, according to the season. July apparently, in most French localities, is the time of greatest abundance of the species. June records are scarce, and emergence in that month must be looked on as exceptional. The earliest date I can find is June 20th at St. Martin de Vésubie (Reverdin), the latest August 22nd at St. Baume (Tring Museum coll.); the longest period of flight in one locality June 20th–July 29th, St. Martin de Vésubie (Reverdin). *Bellieri* is most often taken at Larche in August, but it is not rare in July, and can also appear in June, *e.g.* St. Martin de Vésubie June 29th (Reverdin).

DISTRIBUTION.—The distribution of *foulquieri* is limited; so far as we at present know, with certainty, it is restricted to south-eastern France and northern Italy. It seems probable that it occurs in Spain, and we have one record of Sagarra's that can most probably be taken as proof of the fact. Querci has reported it more recently from several localities in north-eastern Spain. Unfortunately, I do not think any of these Spanish records have been confirmed by the dissection of specimens, and, in view of the great similarity of Spanish *alveus* to *foulquieri*, one cannot accept *foulquieri* as a Spanish species until this has been done.

The vertical range of *foulquieri* is considerable, extending from 300 or 400 ft. above sea-level in southern France, to at least 4600 ft. in the Basses Alpes and the Sibillini Mts.

Verity records a specimen of *bellieri* from the Ortler in S. Tyrol (*Ent. Record*, vol. xxxvii, p. 57), but as the specimen is compared by him with Oberthür's Zermatt specimen, it is most likely only an aberration of *alveus*,* as was the supposed Zermatt example. *Foulquieri* does not occur in Switzerland in any form, and it seems improbable that it occurs in the Tyrol either.

Localities:—

France.—St. Zacharie (Foulquier, Oberthür, etc.); Digne (Chapman, Warren, etc.); Entrevaux; Bauvezer; Peyresq; Mt. Ventoux; Vallouise; Dauphiné Alps; St. Martin de Vésubie; Septîmes (Reverdin); St. Baume; Signes (Tring Museum coll.).

Italy.—Roccaraso; Villalago (Wheeler); Pescocostanzo; Gran Sasso; Roccavaro; Formia; Bolognola in the Marshes (Reverdin, Verity); Sibillini Mts.; Valombrosa; Monte Lago; Cameri; Majella; Mt. Meta; Aurunci Mts. (Verity); Rivoli; Valdieri (Chapman coll.).

Spain.—Serres de Berti (Sagarra). (Wants confirmation.)

IV. CINARAE Group.

STRUCTURAL CHARACTERISTICS.—Tenth sternite in male incomplete; lateral apophyses and cuiller as in the *alveus* group, but the latter slightly narrower; style very long and slender, folded over at its base; ventral line of clasp straight.

* Dr. Verity has since informed me that he believes this to be the case.

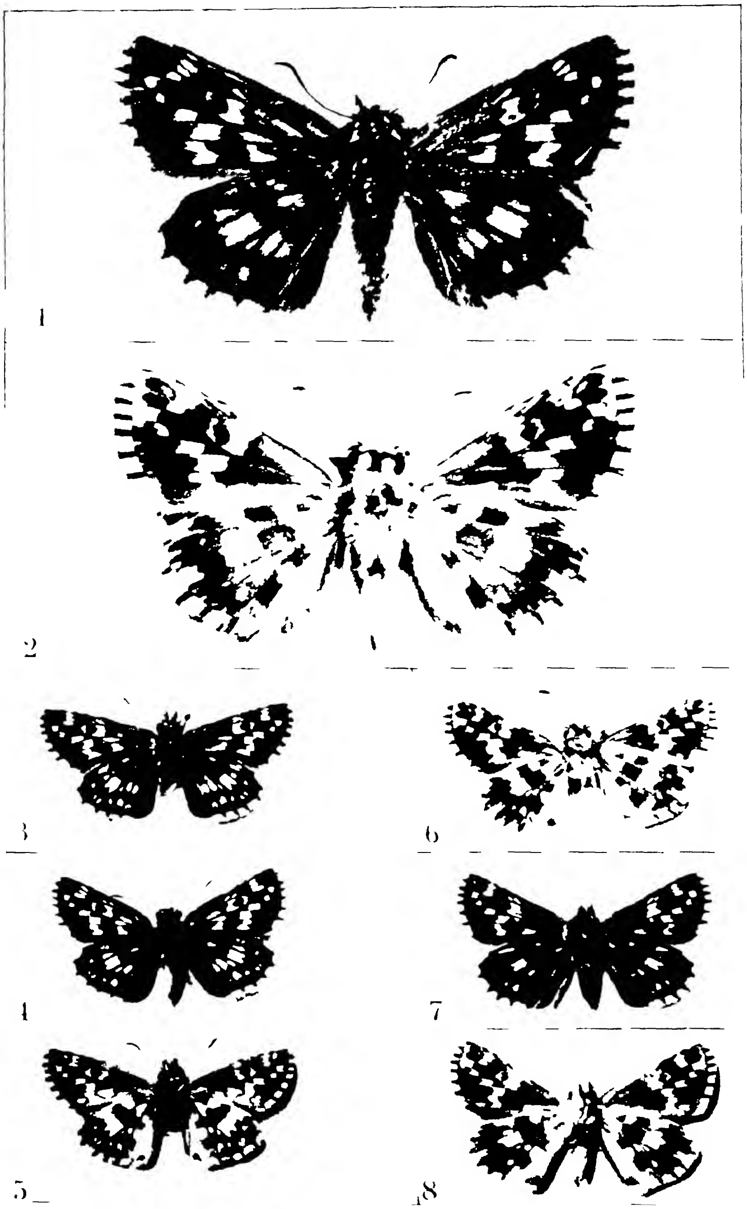
CHARACTERISTIC FACIES.—As given for the species, *cinarae* standing alone; no other known species presents the same remarkable combination of structural characteristics.

Hesperia cinarae, Rambur. (Pl. XLVIII.)

IDENTIFICATION.—*Genitalia.* (Pl. XLIV, fig. 4.) The genital armature of this species is of an extremely specialised nature. The uncus is very long and narrow; the lateral apophyses of the triangular form, seen in the *alveus* group, with their distal margins concave, and the stem which supports each apophysis long and slender, as in *foulquieri*, but the body of the apophyses is well developed and of a length suggestive of *alveus*, an interesting combination of characters. The cuiller of the type of the *alveus* group, its greatest horizontal measurement little more than half its greatest vertical measurement, thus approaching *armoricanus*. The dorsal aspect of the cuiller is flat, the apex nearly a right angle, bluntly rounded off; the free part of the proximal edge straight; the stylifer large, appearing considerably larger than in the *alveus* group, though there is not much difference in reality, as the base of the style is very broad, starting from the lower edge of the dark band which can be seen crossing the lower aspect of the style in the photograph on Plate XLIV. This dark band is of course only the dorsal rim of the secondary semiclasp, showing through the base of the style. The antistyle very broad at its base, short, and ending squarely, directed downwards. The style very broad at its point of origin, tapering rapidly as it rises above the harpe, where it is bent over (after the manner characteristic of the species of the *centaureae* group) and assumes a narrow ribbon-like formation extending in unaltered form some distance, and then expanding again to about twice the width as it nears its termination, the actual point bearing several strong spines. In the photograph it appears to be the same width from where it bends over to the end, but this is owing to the mounting of the specimen. It is extremely difficult to get the terminal expansion to remain flat in mounting, so much so, that it seems probable that it is natural to the process to be in a permanently curled condition. It is possible, however, to mount it absolutely flat without apparently in any way fracturing it, which is not usually the case with naturally and permanently curved surfaces, so which is the natural position remains questionable.

There can never be any difficulty in identifying *cinarae* anatomically; the combination of the principal characteristics of two other groups (cuiller, *alveus* group; style, *centaureae* group) renders it unmistakable, although these structures in *cinarae* are specialised in their own way.

General features.—Size, 32–38 mm. Apparently fairly constant. *Upperside:*—Fore-wings: discoidal series usually complete, although the 3rd spot may be wanting occasionally, 1st and 2nd usually united, forming a more or less wedge-shaped spot pointing towards the base of the wings, the 4th (discoidal lunule) very broad. Median row complete, composed of very large straight-edged spots, the 1st, 2nd, 3rd and 4th being the largest, and practically equal in size to the discoidal lunule. Discal spot very narrow; outer row wanting; subcostal spots very variable, one, two or three may be present, situated over the discoidal lunule. Hind-wings: 2nd and 3rd basal spots usually visible; median band very distinct, the spots as clear as those of the fore-wings, usually complete; marginal row variable, usually composed of six distinct, clear and separated spots. *Underside:*—Fore-wings: discoidal series incomplete, 1st spot occasionally present, as well as the discoidal lunule; median row complete; discal spot very narrow and sharply defined; all these standing out very clearly against the dark background; subcostal spots just discernible in the pale suffusion which runs along the costa. Hind-wings: basal spots distinct; median band complete, the spots between nervures 2 and 4 often very small but present, inner edge of central spot straight; marginal



Hesperia cinara

1 Upperside × 2 2 Underside, × 2

Natural size

3	Tragacete Spain	6	Kurdistan
4	Taganrog Russia	7	Sarepta.
5	Tragacete Spain	8	,,

row variable, composed of five spots of very different sizes; ground-colour ranging from a dull to a bright yellow-ochre, of uneven density, the dark subscaling showing through in places; nervures variable, either lined in a brighter yellow than the ground-colour and showing in consequence distinctly, or covered uniformly by the ground-colour and scarcely visible except between the white spots.

Comparison with other Approximating Species of the Genus.—*Cinarae* is almost as easily distinguished superficially as anatomically, no other species of the genus bearing anything like such heavy, broad white markings on the upperside of the fore-wings, accompanied by such clear white markings on the hind-wings. *Fritillum* makes the closest approach to it in these particulars, but the spots on the fore-wings of the latter are much smaller and squarer in contrast to their more rectangular shape in *cinarae*, and the median band of the hind-wings is much narrower. The two species occur together in Spain, but even apart from the points just mentioned, the beautiful ground-colour of the underside of the hind-wings in *fritillum* s.-sp. *iberica*, with the white spots buff-coloured, should prevent any possible confusion between the two. The above-mentioned characters of the upperside also distinguish *cinarae* from *foulquieri* or any member of the *alveus* group, which are all more or less similar to it on the underside.

Sexual Dimorphism.—There is very little difference between the sexes in *cinarae*. The ♀ on the average may be a little larger, but both sexes reach both extremes of size. In the ♂ there is a certain amount of very pale golden scaling over the basal area of the fore-wings; there seems, as a rule, to be less of this in the ♀, though some is always present. The ♂ has a costal fold on the fore-wings, which the ♀ has not.

Variation.—So far as one can tell from decidedly limited material, *cinarae* is not a variable species. No subspecies, or even aberrations, have been named. It is quite remarkable how few collectors have ever seen the species, much less taken it; this may account for the lack of named forms. Among the specimens I have examined there was only one which suggested that it might belong to a definable race. It is a Spanish specimen, the only one from that country I know of in any collection public or private. In it the undersides of the hind-wings are much brighter yellow than is usual in Eastern European or Asiatic specimens (which are invariably of a very dull ochre), and the nervures are distinctly outlined in light yellow and quite conspicuous, whereas in Eastern specimens they are scarcely visible against the background. There are one or two other points of difference about the Spanish specimen, but as it is a solitary example, one cannot accept it as any proof that all Spanish specimens differ in this manner from the Eastern ones. The specimen is figured on Plate XLVIII, figs. 3 and 5, the difference in colour being lost in the photograph. The nervures on the underside of the hind-wings can be clearly seen, and appear to be sharply defined; they too, however, make a far stronger contrast in reality than the photograph suggests.

It will be interesting to see in the future, when a series of Spanish *cinarae* is obtainable, if this specimen is an accurate sample of Spanish *cinarae* or only an aberration. Considering how constant all the Eastern specimens are (for apart from the one specimen, nothing worth noting as a variety has come to my notice), it seems more than likely that the former is the correct supposition; the distribution of the species further supports the idea that the Spanish form would differ from the Eastern race.

DATE OF EMERGENCE AND DURATION OF FLIGHT PERIOD.—On this question we have scarcely any data. Mabille states that it occurs in June; specimens in collections are invariably without any dates attached to them, having mostly been supplied by dealers. The Spanish specimen previously mentioned, was taken between the 18th and the 26th of July, 1901. From this it seems that the species flies in June and July.

DISTRIBUTION.—The geographical distribution of *cinarae* is, with the exception of *freija*, the most remarkable of any of the European Hesperids. It occurs in Spain and the regions bordering the Black Sea, being absolutely wanting anywhere in between. Although reputed to occur in Spain, I was becoming very doubtful if it really did so, for not only was there no Spanish specimen in any collection I know of (Reverdin coll., British Museum coll., Tring Museum coll., etc.), but no entomologist that I know of had ever seen a Spanish specimen. Mabille, in Seitz's *Macrolepidoptera*, does not mention Spain, and the Rambur collection was in his possession, so that it seemed fairly certain that he would have had Spanish specimens if they existed; and Oberthür only refers to Eastern localities. Considering these facts, a single specimen from some dealer bearing the label "Spain" without further data (except the dealer's name) would by no means have convinced me, but I had the great good fortune to find the specimen figured on Plate XLVIII, in a manner which left no room for doubt. It was among a series of *fritillum* s.-sp. *iberica* in the Chapman collection, which came from Tragacete, all of which had been taken by Chapman himself, and were labelled "Tragacete 18 26. VII, 01. T.A.C." Although there was no doubt about what the specimen was, I mounted the genitalia, so as to leave no point that could be questioned. *Cinarae* is therefore unquestionably a Spanish insect. The specimen is in good condition, but it cannot have been at all plentiful where it was captured, for although Chapman took a long series of the *iberica*, there was only the one *cinarae*.

European localities :—

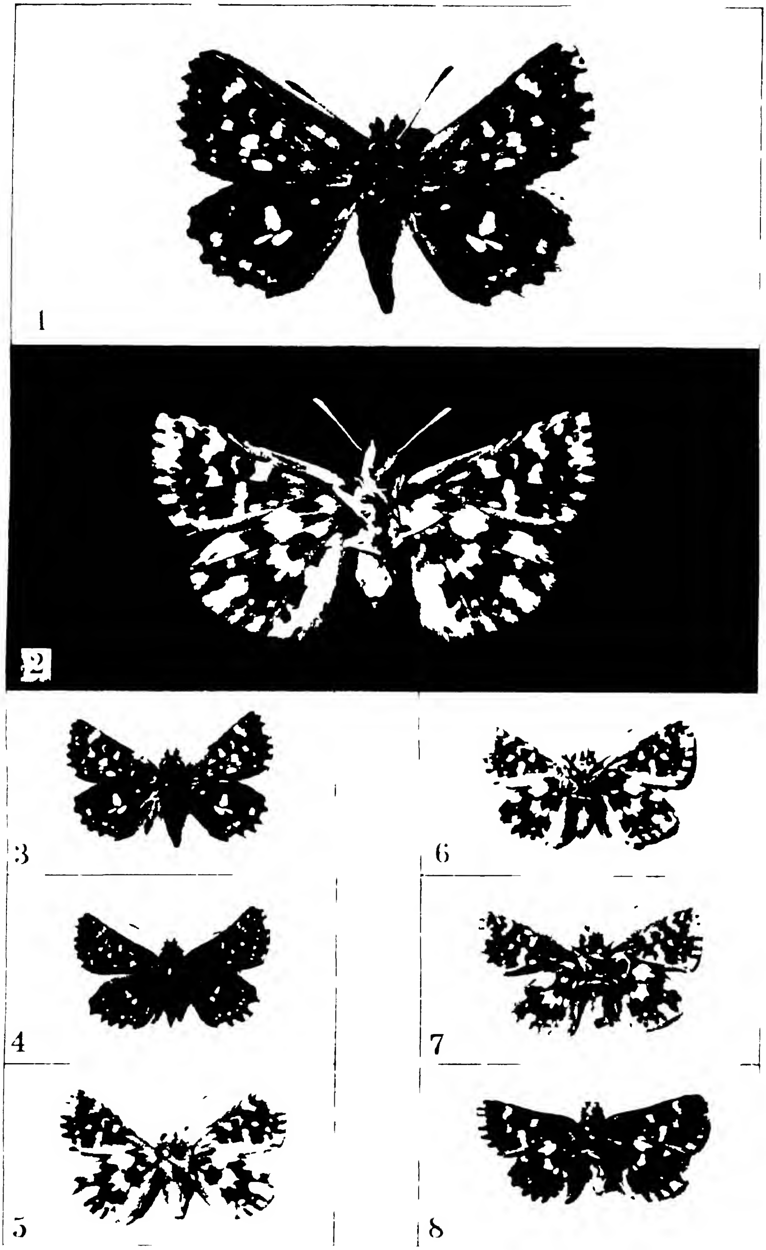
Bulgaria.—Bulgaria (Mabille). This record is accepted on the strength of Mabille's identification.
Russia.—Sarepta (Reverdin, Oberthür); Taganrog (Chapman coll.).
Spain.—Tragacete (Chapman).
Turkey.—Turkey (Tring Museum coll., Mabille). ? European.

Beyond the European borders *cinarae* extends well into Asia, *e.g.* Kurdistan (Chapman coll.); Asia Minor (Mabille).

Genus **POWELLIA**, Tutt.

STRUCTURAL CHARACTERISTICS.—Harpe strongly developed; long; extending to distal extremity of clasp, terminating on summit of cuiller; without style or antistyle. 10th sternite partially developed; united or not united ventrally.

SUPERFICIAL CHARACTERISTICS.—Black species with white or ochreous spots on the upperside: outer row of spots on fore-wings complete, but very small and sharply defined, situated nearer to outer margin of wing than to the median row of spots; median row complete or incomplete; discal spot half-way between discoidal lunule and median row; 5th black bar of fringes of fore-wings usually wanting.



J. Bale, Sons & D., Ltd. Photos [illegible]

Powellia sertorius

1 Upperside [illegible]. 2 Underside [illegible]

Natural size

3 [illegible] Vernayaz (Valais)
4 [illegible] Rochers de Naye (Vaud)
5 [illegible] Vernayaz (Valais)
6 [illegible] race *gavarniensis*. Gavarnie
7 [illegible] ,, ,, ab. [illegible] Gavarnie
8 [illegible] ,, ,, ,,

SERTORIUS Group.

Structural Characteristics.—In male; lateral apophyses of the 10th sternite free, not united ventrally.

Characteristic Facies.—Small white spots on upperside fore-wings, and median band on underside hind-wings connecting with 1st or 2nd white spot between nervures 7 and 8; or, large white spots on upperside fore-wings, and median band underside connecting with 2nd white spot between nervures 7 and 8.

Powellia sertorius, Hoffmannsegg, (sao, Hb.). (Pls. XLIX and L.)

[Note.—It is with the greatest regret that I find I am obliged, by the laws of nomenclature, to change the name of this well-known species. The first author to use the name *sao* was Bergsträsser, and there is no doubt that he applied the name to *malvae*, L. All his work proves this clearly, and even if it did not do so, his own note, that his *sao* = *malvae minor*. Esp., would be final. The species therefore will have to be known as *sertorius*, Hoffmsgg., in future.]

Identification. *Genitalia.* (Pls. XLIV, fig. 5, and LI, fig. 1.) The uncus short, and fairly broad; the lateral apophyses short, broad processes, rounded off at their termination, which is densely covered with short spines. The clasp more or less oval in outline, the dorsal line of the harpe being curved throughout its entire length, and that structure also of almost equal width throughout, terminating in a somewhat rounded knob; ventral line of clasp pronouncedly convex; cuiller small, only a little broader than the harpe, stretching half the length of the clasp. The outline of the clasp and form of the harpe in the *sertorius* group is very specialised, which, while enabling the species to be very easily identified from those of other groups, makes it more difficult to distinguish between themselves. *Phlomidis* and *galba* can easily be separated from the others by features of the clasp, but in *sertorius, therapne, ali* and *orbifer*, the clasp is practically identical (there is a slight difference between *sertorius* and *orbifer*). The only character which is constantly different in these four species is the form of the lateral apophyses. The different forms of these processes can be better grasped by examination of the photographs on Plate LI than by any description. Fig. 1 *sertorius*, fig. 2 *orbifer*, fig. 3 *ali*, and fig. 4 *therapne*. Although *ali* is not European it is included here for the sake of completeness. It will be seen in the photographs that each apophysis is shaped somewhat like a foot; in *sertorius* it is of even width throughout with a broad rounded "toe"; in *orbifer* it is still more foot-like, the "sole" considerably concave, and narrowing in towards the "toe," which is more pointed; in *ali* it is less foot-like, the toe portion alone projecting beyond the side-piece of the apophysis, or what should represent the ankle; the "toe" is sharply pointed and thickly covered with strong spines as in the others; *therapne* is somewhat intermediate between *ali* and *orbifer*, a little more "toe" projecting than in the former, but less pointed and as broad as in the latter.

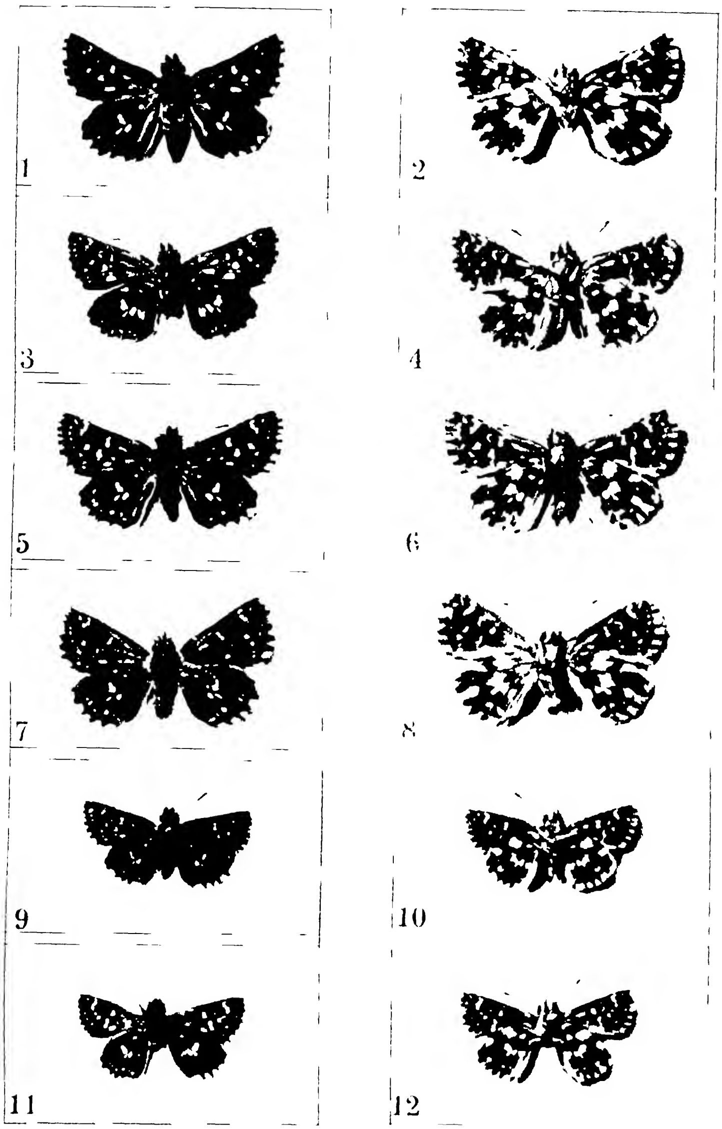
Unfortunately these structures are small, and consequently difficult to observe, or to mount in a clear manner. In the photographs, which are magnified one hundred diameters, one apophysis only of each species is shown, as it was found necessary to dissect each out of the main body and mount separately in order to get a clear photograph.

I have said that the characteristic forms of the apophyses are constant; it would be more correct to say that in *ali, therapne* and *orbifer* they are constant, for in *sertorius* there undoubtedly exists some variation. The form shown in the photograph is that usually found in *sertorius*, but I have seen many specimens of

the latter which exhibit formations very close to *orbifer* and *therapne*, most frequently the former. This is unquestionably a parallel case to some of those structural variations which occur in *alveus*; the parent species still varying in the manner which led to the evolution of the more recent species. On account of the existence of this variation, it is interesting to note another point of difference in the clasp between *sertorius* and *orbifer*, which is so slight that it might easily have escaped notice had there been other more obvious characters available.

In both *sertorius* and *orbifer*, at the distal end of the primary semiclasp, there can be seen rudiments of the terminal portion of a subharpal plate; in the photograph of *sertorius* (Pl. XLIV, fig. 5) this appears like a black, somewhat triangular patch; in fig. 6, *orbifer*, it is hardly visible. This rudiment of the subharpal plate is composed of a central rope-like formation, which runs along horizontally above the cuiller and then rises vertically, at almost a right angle, towards the harpe. Throughout its length it is densely covered with fine hairs, which extend on both sides of the central cord and give it a very suggestive likeness to a centipede. In *sertorius* the vertical portion is always as strongly, or more strongly, developed than the horizontal; in *orbifer* the vertical portion is always much weaker than the horizontal, and often scarcely visible. The formation of these rudiments of the subharpal plate cannot be observed without a microscope, but under a strong hand lens the difference between the two species can be seen. In *sertorius* it appears as a dark irregular line, forming a sharp angle shortly before it terminates; and, in *orbifer*, as a horizontal and not very dense line, getting broader at its distal end. There is some variation in these rudiments too, and it is occasionally difficult to decide which formation a given specimen is closest to; on the whole, however, they are as constant as the lateral apophyses, and have the advantage of not being liable to become displaced or distorted in mounting, as the latter are, and are therefore often of use when the apophyses are not.

General features.—Size, 26–28 mm., average, exceptionally 23–31 mm. *Upperside:*—Fore-wings: discoidal series incomplete and variable, 1st spot often, 2nd occasionally, present, 3rd never present, discoidal lunule always present but variable in size. (It is doubtful whether the 1st spot of the discoidal series should not be said to be united with the 1st spot of the median row, the former being more elongated than any of the other spots, the latter—when present—a mere point. There is endless variation in the position of these spots and of the 2nd spots of both series.) Median row complete or incomplete, more often the latter, 1st, 2nd and 5th spots frequently obsolete, the 3rd the largest, 6–9 always increasing in size upwards. Outer row complete, composed of eight very fine, sharply defined white points; discal spot very narrow, but distinct; subcostal spots wanting. Hind-wings: 2nd basal spot clear but small; median band represented by two or three spots between nervures 2 and 6, *i.e.* the 2nd, 3rd and 4th spots of the band. The 3rd is often wanting; the 2nd and 4th together look somewhat like a slightly inclined exclamation mark. Marginal row composed of small spots, of which there may be eight, though more often there are fewer. *Underside:*—Fore-wings: discoidal lunule present, and sometimes the 1st spot of the series as well; median row more often complete than on the upperside; discal spot very sharply defined; outer row complete, spots 5–8 often merging with the white of the fringes; all the other spots standing out very clearly against a dark background, except on the basal area of the wing, which is somewhat suffused with greyish-white varying to orange, which also extends up the costa, and through which, in the discoidal cell, the inner discal spot is occasionally visible. Hind-wings: basal spots very small, that is the 1st and 2nd, the 3rd often cannot be called a spot; median band complete, all the spots practically touching, of very irregular shapes and sizes, mostly sharply angled; marginal row complete, composed of seven spots, of which the 1st (often lost in the marginal suffusion), 2nd, 3rd, 4th and 6th are mere dots, separated from the margin, and the 5th and 7th very large spots united to the margin. Ground-colour varying shades of red-orange.



J. Bale, S. & D., Ltd. Photos B. C. S. Warren

Powellia sertorius

Natural size.

1—6	♂. race *guadarramensis*	La Granja	
7 and 8.	♀. ,, ,, ,,	,,	,,
9 and 10	♂ race *gracilis*.	Navalperal.	
11 and 12.	♀. ,, ,,	Canales	(Logrono)

COMPARISON WITH THE OTHER SPECIES OF THE GROUP.—*Sertorius* is a very distinct species which will never be difficult to distinguish. Small specimens of it come closer to *therapne* and *ali* than to any other species. From the former *sertorius* can of course always be distinguished by the pure white of the spots on the upperside; the latter is confined to North Africa, where *sertorius* does not occur. From *orbifer* the sharply angulated forms of the spots of the median band on the underside will always distinguish *sertorius*, as does also the much redder shade of the ground-colour of the hind-wings (underside). *Phlomidis*, with its heavy white markings on the upperside, so similar to the species of the *geron* group, will never be confused with *sertorius*.

Outside the group, no known species of the genus is at all similar to *sertorius*.

SEXUAL DIMORPHISM.—There is practically no superficial difference between the sexes in this species. On an average the ♀ might be said to be a little larger than the ♂, but both sexes vary in this respect, and very small specimens of the ♀ are quite common.

VARIATION.—*Sertorius* is a species rich in minor variations, but it does not seem to have developed any true subspecies, so far as we at present know.

race **gavarniensis**, nov. (Pl. XLIX, figs. 6–8.)

Of average size, 26–30 mm. *Upperside* as in *sertorius*. *Underside:* all those parts which are white in *sertorius*, i.e. body, legs, the underneath of the palpi and antennae, the costa and outer margin of the fore-wings, and the fringes of all the wings, all of a rich buff, almost orange colour; the ground-colour of the hind-wings brighter and redder than in the type, the combined effect being very brilliant and striking, a typical series of French or Swiss specimens looking very pale in comparison.

Habitat:—Neighbourhood of Gavarnie.

This handsome race is not far removed from subspecific standing, but undoubted specimens of typical *sertorius* occur occasionally at Gavarnie too, so that it must be retained as a race, though the proportion of typical specimens occurring is very small. The beautiful coloration of the underside is lost in the photographs, but if figs. 6, 7 and 8 on Plate XLIX are compared with fig. 5 (an ordinary Swiss specimen) the darker shade of the palpi and fringes is noticeable, also the darker effect of the ground-colour of the hind-wing in fig. 8, as compared with fig. 5. In fig. 7 a slight difference in the shade of the two hind-wings is noticeable; this specimen is very remarkable. The right hind-wing is a bright orange colour, the left is the vivid red of *gavarniensis*.

Single aberrations occur in France, Switzerland and Spain, with a little buff shading on the costa of the fore-wings on the underside, but I have never seen a specimen in which this colour replaces all the white as in *gavarniensis*.

race **guadarramensis**, Warr. (Pl. L, figs. 1–8.)

The largest known race of the species, 30–31 mm. All the coloration very rich. The thin superscaling on the basal area of the upperside of the fore-wings golden-yellow. Underside hind-wings, the ground-colour a vivid red similar to *gavarniensis*.

Habitat:—The neighbourhood of La Granja, Spain.

This race is remarkable for two reasons: (*a*) its great size; and (*b*) its habitat. The size is more remarkable than the measures would suggest, as a glance at Plate L shows; of the habitat we must say a word or two.

All over Spain we find typical-sized *sertorius* (similar to fig. 4, Pl. XLIX)

accompanied by minute specimens of the *gracilis* race (Pl. L, figs. 9–12) in about equal numbers. Everywhere in South Europe the tendency is for *sertorius* to become smaller. In the centre of Spain, at La Granja, occur the usual typical-sized—and also smaller—*sertorius*, but accompanied by a much larger race (*guadarramensis*), constantly larger than the largest aberrations of northern localities. When *guadarramensis* is seen beside the tiny race of the south, as on Plate L, one cannot fail to be struck by the remarkable fact that such a race should be developed in a region where the latter race almost outnumbers the type.

The series from which *guadarramensis* was described was collected by the late Rev. F. E. Lowe, in 1908, and is now in the Oxford University Museum; there were eight specimens, six of which are shown on Plate L. One of them is an interesting aberration (see fig. 3). In it the white spots of the median band on the upperside are considerably enlarged, while on the underside the ground-colour of the hind-wings has lost most of the red coloration except as streaks along the nervures, the dark subscaling showing plainly everywhere between the latter.

race **eucrate,** Esp.

Small specimens, 23–24 mm., with pale coloration underneath, said to occur in South Europe.

Most of the very small specimens from Spain and the south of France cannot come under this name, for usually there is a tendency in such specimens to a deeper, and not paler, shade of colouring underneath. Very diminutive specimens, the same size as figs. 9-12 on Plate L, occur among South German specimens, with a very pale underside, having lost all the red shade from the ground-colour of the hind-wings. These presumably are true *eucrate.*

race **gracilis,** Vty. (Pl. L, figs. 9–12.)

Very small specimens, 23 24 mm., of normal coloration on the underside, occurring in both broods in Central Italy.

This race only differs from the last in colour; as already noted, it occurs in Spain commonly, and can be found almost anywhere with the type aberrationally.

Another form has been described by Verity as having the outer row of spots on the upperside "faint and incomplete." As the latter terms are non-definable, the name had best be restricted to the extreme form which Verity mentions:

ab. **parvula,** Vty.

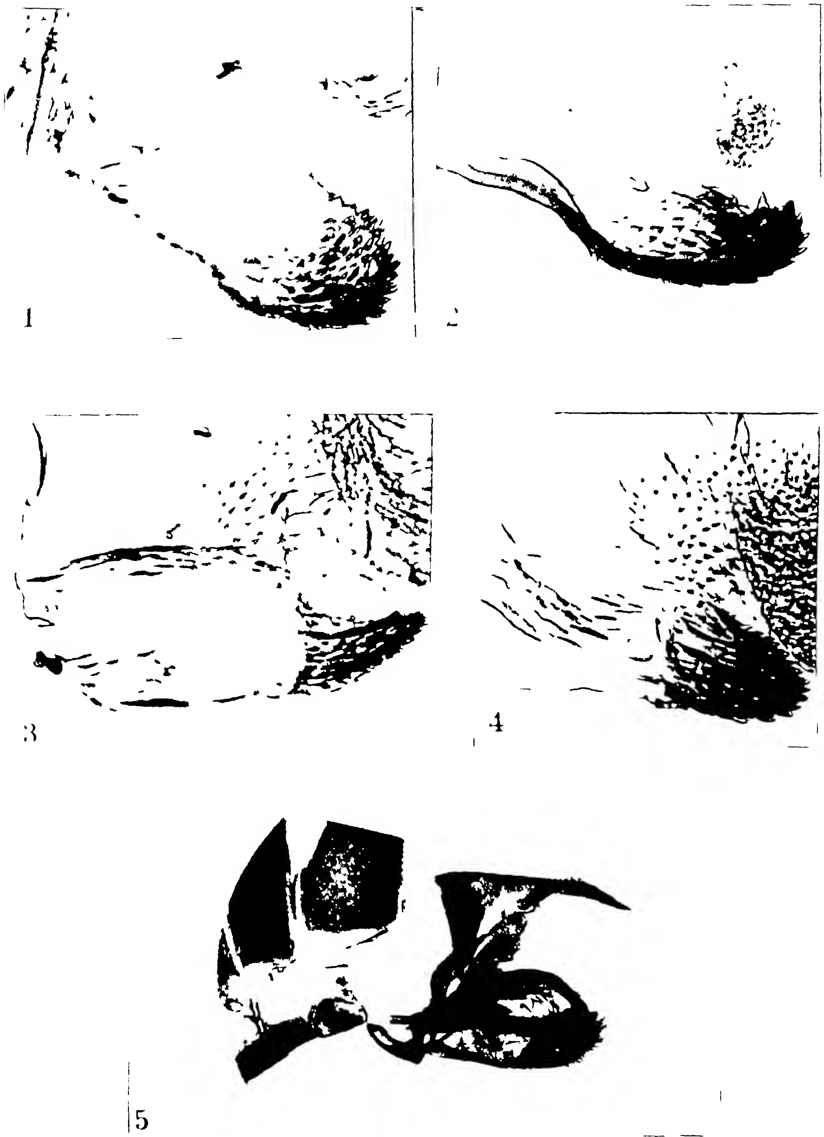
Specimens in which the outer row of spots of fore-wings, and marginal row of hind-wings are wanting.

ab. **subtus-brunnea,** Rev.

This name was given to a specimen, taken at Tramelan (Jura), in which the ground-colour of the underside of the hind-wings was a beautiful chestnut-brown colour. A striking aberration.

The ground-colour varies a great deal in shade, but keeping as a rule to some shade of the typical coloration, such a complete change of colour as in *subtus-brunnea* being very rare.

The extent and size of the white spots on the upperside is extremely variable, such variation being usually quite independent of the size of the specimen. Two common forms are shown on Plate XLIX, figs. 3 and 4; it will be noted



Genus *Powellia* male armatures

1 *P. sertorius* Lateral apophyses of 10th sternite 100
2 *P. orbifer* ,,
3 *P. ali* , ,
4 *P. therapne* , ,
5 *P. therapne.*

that, in fig. 4, the spots are just as small as in the diminutive specimens on Plate L. On the underside the same thing occurs, especially on the hind-wings; fig. 8, Pl. XLIX, is rather an extreme form. Specimens with large spots on the upperside of the fore-wings have been named ab. *kempnyi*, Schawerda.

ab. **tesselloides,** H.-S.

This aberration is a very doubtful quantity. The name was given to specimens said to have been taken in Sicily. To the present time, however, I have not been able to obtain an authentic record of the occurrence of *sertorius* in Sicily. The figures given with the original description (Herr.-Sch., *Schmett. Europ.*, Pl. 2, figs. 10 and 11) are very little use, but seem to be *sertorius* more than anything else, though a little larger than usual, and slightly less brightly coloured on the underside. If the specimens figured really came from Sicily, it seems probable that they were some other species, though what species there is no means of telling. Of course in the future a form of *sertorius* may be found to exist in the island, and if so, it will doubtless be what Herrich-Schäffer described as *tesselloides*.

Date of Emergence and Duration of Flight Period.—The species seems to be double-brooded wherever it occurs in the lowlands, and single-brooded in the Alps. The first brood is somewhat extended, and lasts for about two months, beginning in late March or any time in April, according to the locality. The species is strongly affected by altitude; a rise of 1000 ft. or so is enough to delay the emergence by 5 or 6 weeks, and of course abolishes the second brood. The single brood of the Alps varies greatly in its time of appearance. About 4000 ft. it often begins in late May, while at 5000 ft. it is often not out before July.

It is sometimes difficult to say how long the first brood lasts in southern localities, but on the whole it seems that it extends from late March to the end of May, or from mid-April to early June. For example, at Hyères the earliest date noted is March 19th (Chapman), the latest for the first brood May 16th (British Museum coll.); while at St. Maxime I find April 18th (Chapman) to June 2nd (British Museum coll.). At Florence, Querci notes it as not appearing until May 7th, and lasting to June 25th, the second brood beginning early in August. In North Switzerland, at Baden, the first brood extends from late April to late May, the second beginning in early July (Warren); these seem to be the usual dates in the hotter parts of the country too, *e.g.* in the Rhone Valley. The second brood lasts about 6 or 7 weeks, the latest records being Verity's Italian ones of mid-September. September specimens are decidedly rare in more northerly localities. It is remarkable, that in the extreme south of Europe, as in southern Italy and Spain, there is a tendency for the spring emergence to be retarded, and the autumn one to be proportionately prolonged; whereas on the northern shores of the Mediterranean the tendency is to accelerate the spring emergence and often (though not always) to shorten the duration of the autumn brood.

Distribution.—*Sertorius* is a widely distributed species in Central and South-western Europe, but apparently does not extend east of the Adriatic Sea. In Switzerland, though very common in the west, it decreases rapidly as one goes east, becoming extremely local; and in the Grisons I have only been able to find two authentic records of its occurrence: one a specimen taken at Guarda by Chapman, and one specimen in the British Museum from Bergün, taken by Zeller. In South Germany it is also very generally dis-

tributed in Baden, but likewise it does not extend much to the east. The most easterly locality known seems to be Calabria (Verity), where the species reaches approximately 16° E. Long., while further north Ober-Saal in Bavaria at 12° E. Long. is its easterly limit. It apparently does not occur in Austria, though found in the Italian Tyrol.

Localities :—

Belgium.—Widely distributed (Mabille).

France.—St. Christophe; Mt. Dauphin; St. Pierre de Chartreuse; Fontgaillarde (Reverdin); Vernet-les-Bains (Gibbs); Hyères (Tring Museum coll., Chapman); Allos (Chapman, Reverdin); Digne (Chapman, etc.); Gavarnie (Oberthür, Warren); Mt. Cenis; St. Raphael; Vallescure (British Museum coll.); St. Maxime (Chapman, British Museum coll.); St. Martin de Vésubie; Larche; Fontainebleau; Gresy-sur-Aix; Nîmes; Cannes (Chapman); Abriès (Sheldon, Chapman); Costebelle (Wheeler, Chapman); Aix—Provence—Fontbrun (Wheeler); Cauterets; Villeneuve-de-Blaye; Charente; Lozère; Gers; Fôret de Carnelles; Isère (Oberthür).

Germany.—Widely distributed in the west (German authors).
Baden: Freiburg; Alt Breisach (Warren).
Bavaria: Ober-Saal (Verity).

Italy.—Courmayeur; Tuscan Apennines (British Museum coll.); Florence (Verity, etc.); Pallanza; Mendel Pass (Chapman); Stelvio Pass; Mt. Gibbio (Reverdin); Calabria; Mt. Martinello (Reverdin, Verity); Camaione Valley; Mollarino Valley (Querci); Isargo Valley; Atzwang (Verity); St. Gimignano; Fiesole; Assisi; Orvieto (Wheeler).

Spain.—Canales (Pr. Logrono); Cuenca; Tragacete; Bejar; Navalperal (Chapman); Gibraltar; St. Roque (Chapman coll.); Granada; Abarracin (Sheldon, British Museum coll.); La Granja (Lowe, Sheldon); Castille; Andalusia (Oberthür); Cordova; Sevilla; Algeciras (British Museum coll.).

Switzerland.—Elgg; Tramelan; Tessin (Reverdin); Weggis; Vissoye; Val d'Hérens; Guarda (Chapman); Taschalp (Tring Museum coll.); Bergün; Zurich; Zermatt (British Museum coll.); Tinière Valley; Sion; Bex; Aigle; St. Georges; Caux (Wheeler); Laquintal (Wheeler, Warren); Sierre (Sheldon); Baden; Eclépens; St. Triphon; St. Maurice; Vernayaz; Rochers de Naye; Tanay; Kandersteg; Gondo Gorge; Binnental (Warren).

Powellia therapne, Rambur. (Pl. LII.)

Identification.—*Genitalia.* (Pl. LI, figs. 4 and 5.) It is unnecessary to give any detailed description of the genitalia of this species, for the only point of difference between it and *sertorius*, *ali* and *orbifer* has already been described (see *sertorius*); *i.e.* the characteristic formation of the lateral apophyses, fig. 4. From *phlomidis*, it can be distinguished at a glance by the form of the harpe and cuiller.

General features.—Very constant in size, 21-24 mm. *Upperside:*—All the lighter markings, which are white in other species, are ochreous in *therapne*, including the fringes of all the wings. Fore-wings: discoidal series represented by the discoidal lunule, which is broad in proportion to its size, being sometimes practically square; median row incomplete, 5th and 6th spots usually wanting; outer row complete, but very small and faint, usually just visible; discal spot a mere line, and barely visible; subcostal spots wanting. Hind-wings: basal spots wanting; the first three or four spots of median band present; marginal row incomplete, the number and position of spots visible being very variable. *Underside:*—Fore-wings: whole surface suffused with ochre, which sometimes extends to the basal areas and fringes of the hind-wings too. The same markings as on the upperside, but the discal spot strong, and showing much more clearly against a dark background. Hind-wings: basal spots present, the 3rd often only a line bordering the wing; median band complete, composed of sharply angled spots of varying sizes, central one with a straight inner edge; marginal row composed of seven spots, 5th and 7th long, and more or less united to the margin of the wing, the others very small and usually well separated from the margin, rarely the 5th and 7th are separated

from the margin too. Ground-colour deep brownish-red, slightly mottled with darker shades; nervures faintly visible.

Comparison with the other Species of the Group.—The remarkable colouring, especially of the upperside and the underside of the fore-wings, renders *therapne* almost unmistakable, for the other species of the group (with one exception) are all marked with white on the upperside. The exception is the second brood of *ali*, which has a yellowish-red tinge in the light markings on the upperside. This seasonal form, which has been named *therapnoides* by Oberthür, is decidedly suggestive of *therapne*, though on the whole not quite so dark. It can, however, always be distinguished from *therapne* by the different shape of the spots on the underside of the hind-wings. In *therapne* the inner edge of the central spot of the median band is straight, as is also that of the 7th spot of the marginal row. Both these spots have an uneven inner edge in *ali*, projecting very sharply towards the base of the wing; further, the dark shades of the black subscaling showing through the red of the ground-colour of the underside of the hind-wing are, in *ali*, both more pronounced and more numerous than in *therapne*. In the field of course no difficulty can arise, *ali* being confined to North Africa, while *therapne* so far as is known, does not occur there. Mabille in Seitz's *Macrolepidoptera* states that *therapne* inhabits North Africa, but this is probably incorrect, as I have been unable to find any authentic record of the fact, and Powell, who is probably more familiar with the North African region than any other entomologist living, tells me he has never seen an African specimen of *therapne*. There can be little doubt that specimens of *ali* form *therapnoides* were responsible for Mabille's error. Powell notes that *ali* (type) occurs in May, and form *therapnoides* in July, August and September.

Sexual Dimorphism.—Very little superficial difference exists between the sexes in this species. The ochreous spots on the upperside of the fore-wings in the ♀ are usually slightly larger than in the ♂, and also of a brighter colour.

Variation.—The variation, as might be expected in view of the very restricted distribution of the species, is insignificant, and consists almost entirely of an increase or decrease of the ochreous spots on the upperside and the white spots on the underside of the hind-wings. On the upperside of the fore-wings the median row is the most variable feature, any spot from the 1st to the 6th can be lost, and very rarely the 5th and 6th spots may be present. The outer row, always indistinct, is occasionally almost obsolete. I have not yet seen a specimen in which it was completely lost, but in several cases it comes very near to being so. The hind-wings give one the same range of variation as the fore. On the underside the extent of the ochreous suffusion is perhaps the most variable feature, usually covering the whole of the fore-wings but leaving the hind-wings free. Occasionally, however, the basal area of the latter is suffused, and also the fringes and inner margin. Very often in such specimens the half of the white costal spot of the median band which is above nervure 8 is suffused and ochreous in colour, while the lower half, *i.e.* that below nervure 8, remains white; very rarely the whole spot is coloured. The 7th spot of the marginal row is at times suffused too. The size of the spots of the marginal row is also a variable feature, as is the extent to which they are united to, or separated from, the margin. The smallest spots of this series, in spite of their minute size, are not infrequently attached to the margin by a fine stem, so that their actual position is not altered. The ground-colour varies somewhat, occasionally appearing much less red than

the normal shade. All these forms are, however, of a purely aberrational character, and not very pronounced at that, never really altering the characteristic appearance of the species.

Date of Emergence and Duration of Flight Period.—Strangely enough the vast majority of specimens of *therapne* in collections are without dates, but the following few records show that it is double-brooded, even at the highest levels at which it has been captured.

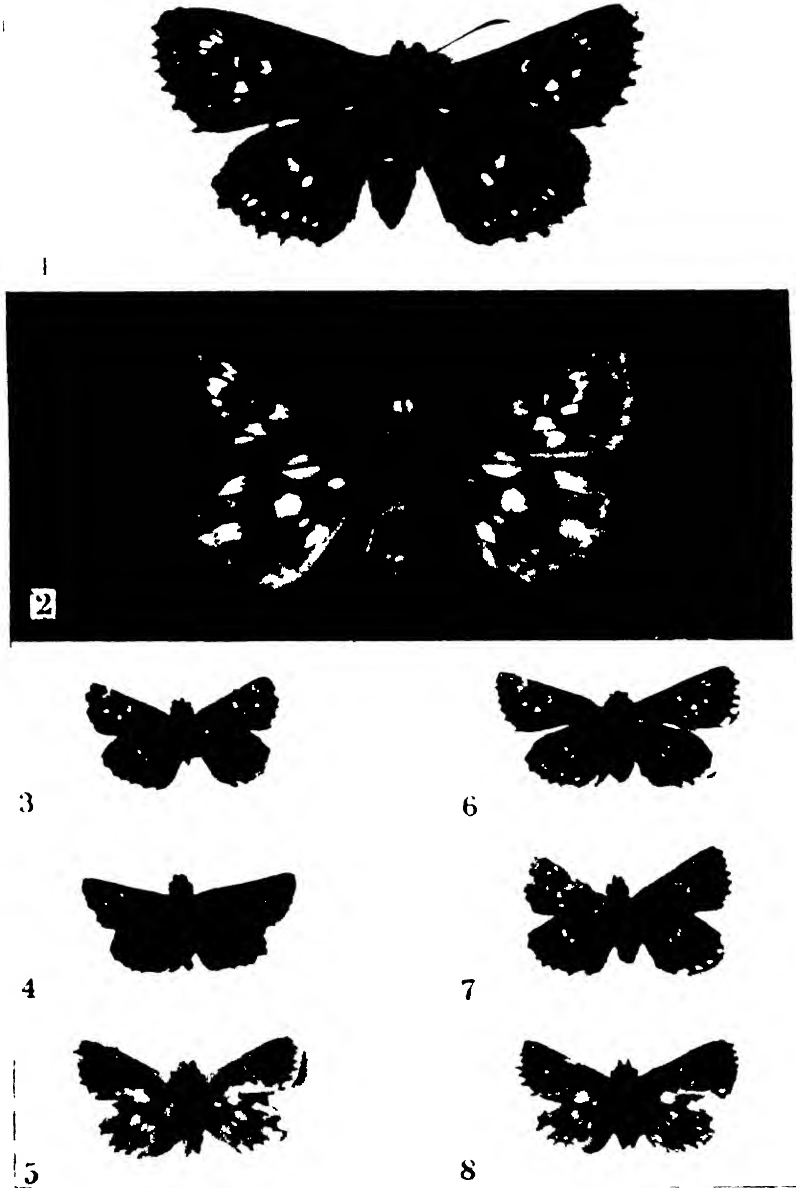
Late April near Ajaccio (Muschamp); June 13th–20th, Aritzo in Sardinia (Tring Museum coll.); July 27th and 28th at Corte (Sheldon); between Vizzavona and Tattone June 16th and 19th, and August 15th–24th, 1925 (Powell). The first brood was almost over when Powell found it, probably it had begun in May; the April record near Ajaccio is at a much lower altitude, where the second brood would emerge in early July. Sheldon's late July specimens at Corte are, of course, second-brood ones, the emergence there being earlier than at the higher level of Vizzavona, but proportionately later than it would be at sea-level.

Distribution.—The species is confined to the islands of Corsica and Sardinia, where it seems to be widely distributed. Mabille's record of North Africa has already been mentioned as undoubtedly erroneous; and Verity writing from personal experience and from the result of a whole season's collecting by Querci, states that *therapne* does not occur on the island of Elba.

Powellia orbifer, Hubner. (Pl. LIII.)

Identification.—*Genitalia.* (Pls. XLIV, fig 6; and LI, fig. 2.) As in the case of *therapne*, the characteristic features of *orbifer* have been already described in connection with *sertorius*. It may, however, appear to anyone looking at the photograph on Plate XLIV, that the outline of the clasp is somewhat different from that of *sertorius*, and also the uncus appears to be much longer. The features of the clasp are correct so far as they go, but the appearance of the uncus is the result of injury in mounting the specimen. There is no difference in that respect between the two species. The form of the harpe is occasionally distinctive, as seen in the photograph, but more often it is exactly similar to *sertorius*, while the latter, very occasionally, develops a broader termination to the harpe. As has been previously noted, the only constant differences between *orbifer* and its near allies are in the form of the lateral apophyses and the rudiments of the subharpal plate.

General features.—Size, 24–30 mm. *Upperside*:—Fore-wings: discoidal series incomplete, 2nd and 3rd spots always wanting, and often the 1st; median row complete or incomplete, but the 5th and 6th spots always very much smaller than the others; outer row complete, composed of eight small but well-defined spots; discal spot very narrow but distinct; subcostal spots wanting. Hind-wings: no basal spots; median band represented by one, two or three, small spots, the upper one being a mere line; marginal row variable, when fully present consisting of eight spots, but most frequently only seven are present. *Underside*:—Fore-wings: inner discal spot often present; discoidal series incomplete, but the 1st and 2nd spots not infrequently present, discoidal lunule always so; median row complete, likewise the outer row; discal spot standing out clearly against the black background. Hind-wings: 1st and 2nd basal spots small, 3rd only represented by a few white scales at the base of the wing, median band complete, composed of five distinct and separated spots, all more or less rounded, the 4th and the 5th the largest, the latter divided by nervure 8; marginal row present, spots 5 and 7 very large and united to the margin, the others very small and separated from the margin. Ground-colour brownish-yellow, nervures scarcely showing at all.



[illegible]

[illegible]

1. Upperside. 2. Underside × [illegible]

Natural size.

3. [illegible] Cetinje, Montenegro. 6. [illegible] Thüringen, Vorarlberg.
4. [illegible] Turkey. 7. Cetinje, Montenegro.
5. 8. Hungary.

COMPARISON WITH THE OTHER SPECIES OF THE GROUP.—In point of size and markings of the upperside *orbifer* is nearer *sertorius* than any of the other species. It can always be distinguished from the latter by the rounded form of the white spots of the median band on the underside, and the fact that those spots are always clearly separated. It further differs from *sertorius* in the ground-colour of the underside of the hind-wings, which never shows any of the red tone that is such a conspicuous feature of the latter. From *phlomidis*, the fine white markings of the upperside and the separated white spots on the underside of the hind-wings keep *orbifer* distinct, and of course the colour of the same markings renders confusion between it and *therapne* impossible. The other species of the genus outside the group are not European, but they all differ from *orbifer* as *phlomidis* does.

SEXUAL DIMORPHISM.—There is not much difference to be noted in the sexes of this species. On the whole the ♀ is slightly the larger of the two, and the spots of the median row on the upperside are often larger than in the ♂, as well as being usually more fully present. The ground-colour of the underside of the hind-wings is generally of a deeper (more orange) shade in the ♀ than in the ♂.

VARIATION.—The variation of *orbifer* in Europe is of little interest, it is essentially an Eastern species, and is far more widely distributed in Asia, where it produces several races. Specimens from various localities in Eastern Europe do not differ from each other in any particular way. There is a certain amount of minor variation to be seen in the white markings of the upperside. The outer row on the fore-wings, usually more or less invisible, is sometimes quite strongly developed with every spot present; occasionally it is reduced to three or four mere points; the median row varies in a similar manner, from its complete form with nine spots to specimens with only four, or even three remaining, the three apical ones; the latter is a rare form. On the hind-wings the variation is perhaps less, but the effect is greater. Specimens without any white occur occasionally; more often the central spot of the median band remains, as a fine white line between nervures 4 and 6, no other spots being visible. On the underside the size of the white spots on the hind-wings is the most variable feature. These range from being so large as to be only separated by the nervures, to being so reduced as to be separated by spaces half their own width. They are, however, never united, nor apparently ever obsolete. The shade of the ground-colour of the hind-wings varies a little, but does not produce anything like the variety of shades that *sertorius* does.

DATE OF EMERGENCE AND DURATION OF FLIGHT PERIOD.—We have not been able to collect as complete information on the emergence and duration of the flight period of this species as one would wish, or would have expected for so well-known a species. Till now it has usually been supposed that it is single-brooded, occurring from May to July according to the locality. June is by far the most frequently recorded month, but there are some August records, which made one wonder if the single-brood theory was correct. Graves definitely shows that there are two broods in Palestine, and states that he finds the first from the middle of April to the end of May, and the second from late June to August (form *secunda*, Graves). He also mentions some specimens at Beirut in early September, and questions if these are a third brood. From what I know of the habits of other well-known species, however, I have no doubt the September specimens were late second-brood ones. In view of these records of Graves',

it is probable that the species is double-brooded in Europe too; and the poor data in our possession seem to corroborate this. Budapest is the only European locality from which we have more than single dates; it gives us the following: May 11th–June 3rd, 1909 and 1910 (Sheldon); June 11th, 1907 (A. H. Jones); June 1892 and August 27th, 1898 (Chapman coll.). These dates rather suggest two broods, and Kane apparently implies two broods by the dates he gives—May and July. Other late records are: Jablanica, July 9th–11th, 1912 (Gibbs); Lerageve, July (British Museum coll.); Thüringen, July 20th, 1897 (Chapman). The Budapest dates are unfortunately in different years, but even so it seems that May 11th–August 27th is too long a period for one brood. It is probable then that there are two broods, the first from early May to mid-June, the second from mid-July on. It must not be forgotten that it is quite possible the species emerges before May, though we have no records to that effect.

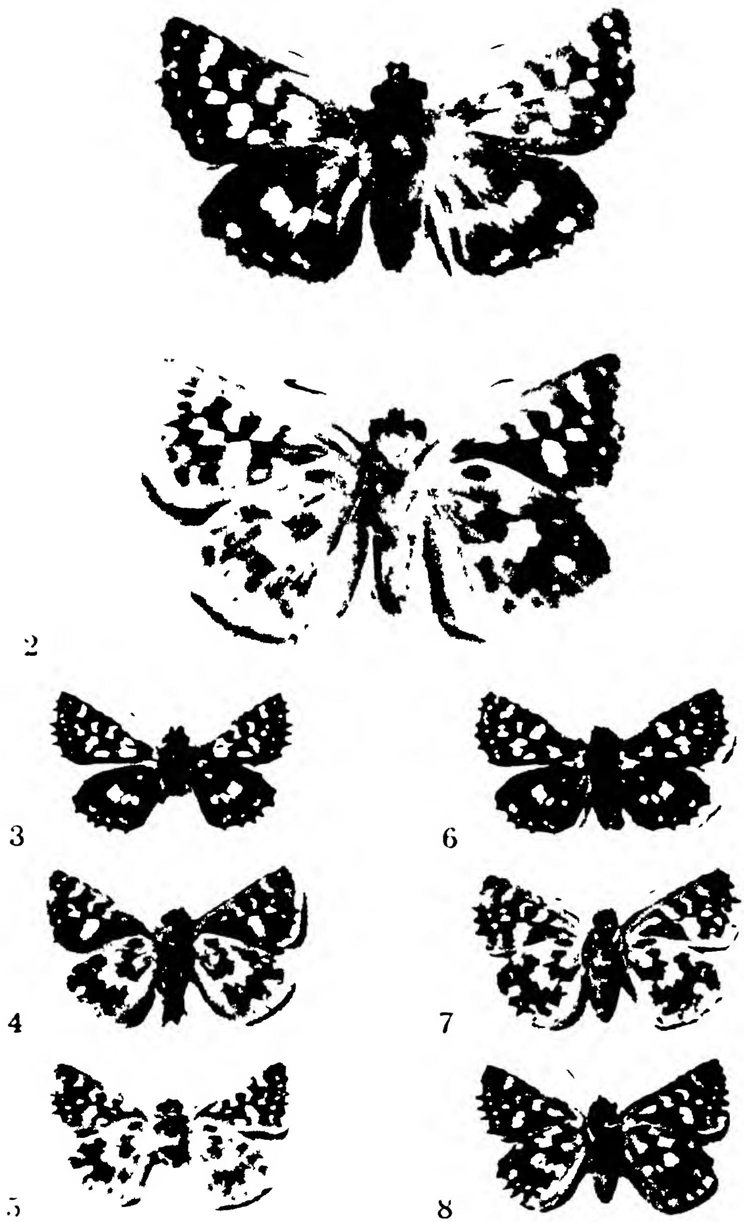
DISTRIBUTION.—The distribution of *orbifer* in Europe is restricted to the south-eastern area, *i.e.* south-east Russia, Hungary and the Balkans. Strangely enough its western boundary is uncertain. Common on the east coast of the Adriatic and on the island of Corfu, it does not seem to occur in Italy, but does in Sicily. Verity notes that he has never seen a specimen from the south of the Tyrol; but it seems probable that it occurs in Austria. The locality referred to in the most westerly record I have been able to find is unfortunately a little uncertain. In the Chapman collection there were two specimens, a ♂ and a ♀, labelled "Thüringen 20. VII. 97" in Chapman's writing, without further indication as to whether that referred to Germany or Austria. I have, after comparison with many other records of Chapman's, accepted it as standing for the latter, for the specimens were taken by himself, and in 1897 he collected in July in several localities in western Austria, not far from Thüringen.

European localities:—

Austria.—Vorarlberg: Thüringen (Chapman).
Greece.—Greece (Reverdin); Athens; Salonika; Struma Valley (British Museum coll.).
  Corfu: (Reverdin).
Hungary.—Budapest (Reverdin, Sheldon, etc.); Svabhezy (Budapest) (Jones).
Italy.—Sicily (Verity).
Jugoslavia.—Croatia: Zengg (Tring Museum coll.).
  Bosnia: Lerageve (British Museum coll.).
  Dalmatia: Dalmatia (British Museum coll.); Bocche di Cattaro (Chapman coll.).
  Herzegovina: Jablanica (Gibbs).
  Montenegro: Cetinje (Gibbs).
Russia.—Crimea (Sheldon).
Turkey.—Turkey (Chapman coll.). ? European.

Powellia phlomidis, Herrich-Schäffer. (Pl. LIV.)

IDENTIFICATION.—*Genitalia.* (Pl. LV, fig. 1.) The uncus short, and tapering gradually to its termination. The lateral apophyses of the 10th sternite somewhat similar to those of *sertorius*, but slightly narrower. The clasp is very specialised in formation. The terminal portions of the harpe and cuiller, instead of meeting more or less squarely and fully, only touch on their internal extremities, from which point the terminal line of the harpe slopes up, and that of the cuiller down, both in more or less straight lines to their external extremities; this forms a V-shaped gap in the distal aspect of the clasp, the point of the V directed towards the base of the clasp. The harpe, unlike that of any of the other species of the group, gradually extends in width towards its termination, which is square and is the point of its greatest



[illegible] [illegible] Warren

Powellia phlomidis

1. Upperside × 2 ♂. 2. Underside, × 2

Natural size

3	♂ Turkey, Asia Minor	6	Amasia
4	♂ Amasia	7	
5	Turkey, Asia Minor	8	

breadth. At the lower terminal angle it develops a cluster of strong spines, and the cuiller is likewise armed at its distal extremity. The proximal end of the clasp very broad and square.

These characters combine to give the armature of *phlomidis* a very distinctive appearance. There can never be the least difficulty in distinguishing it from any other Palaearctic Hesperid.

General features.—Size, 33–36 mm. *Upperside:*—Fore-wings: discoidal series incomplete, 1st spot and discoidal lunule present; inner discal spot frequently present, and a considerable amount of white scaling all over the basal area of the wing, developing, fairly frequently, into a more or less distinct spot below the inner discal spot. Median row complete, composed of large square-shaped spots; discal spot present, usually equal in size to the discoidal lunule; subcostal spots wanting; outer row complete, composed of eight small but very distinct spots. Hind-wings: basal spots represented by the 2nd, which is small and somewhat circular; four spots of the median band usually present, the 4th the largest; marginal row incomplete, usually five or six spots present. *Underside:*—Fore-wings: inner discal spot pronounced; discoidal lunule broad, often larger than on the upperside, 1st spot of this series faintly visible; median row and discal spot distinct; all these markings of a broad and heavy nature, outer row present, first four spots distinct, last four blurred by white suffusion from the margin; costa white, ground-colour otherwise very dark. Hind-wings: basal spots indistinct, 2nd clearest and best developed, 3rd often wanting, 1st also occasionally lost; median band complete, all the spots usually united; marginal row complete, consisting of seven spots more or less united to the margin of the wing. Ground-colour greenish yellow and slightly mottled; nervures scarcely visible.

COMPARISON WITH THE OTHER SPECIES OF THE GROUP.—*Phlomidis*, in spite of the characteristic position of the median band on the underside, is a very different-looking insect, on the under as well as on the upperside, from the other species of the group. The broad white markings and the pronounced basal suffusion on the upperside of the fore-wings render it unmistakable.

COMPARISON WITH OTHER APPROXIMATING SPECIES OF THE GENUS.—None of the species of the *geron* group are European, nevertheless, as *phlomidis* has always been classed with them in the past, it may not be out of place to mention briefly how it differs from them. *Phlomidis*, while very similar to them on the upperside, can always be easily distinguished by the direction of the median band on the underside. This (as in all the *sertorius* group species except *galba*) runs from the 2nd white spot between nervures 7 and 8 to the centre of the inner margin, while in all the *geron* group species it runs from the 1st white spot between those nervures.

SEXUAL DIMORPHISM.—The sexes in *phlomidis* differ more than is noticeable among the other species of the group. There is always a thick suffusion of white scales on the basal area of the fore-wings in the ♂, which extends along the costa as far as the discoidal lunule, and often somewhat obscures the inner discal spot. In the ♀ this suffusion is much less marked, and may on occasions be quite absent, leaving the inner discal spot standing out sharply against a black background. It can also on occasions be present to a certain extent, but never so pronouncedly as in the ♂; fig. 6 on Plate LIV shows such an example, but it is rather an unusual specimen because the inner discal spot is quite absent. The dark basal half of the costa is usually a striking feature of the ♀. The first three spots of the median band on the upperside are also usually less developed in the ♀ than in the ♂, while on the underside of the hind-wings the

ground-colour is generally of a greener shade and darker in the ♀, and the white spot of the median band between nervures 6 and 7 is smaller than in the ♂, and, not very rarely, quite absent, which gives the median band a somewhat disconnected look in the ♀ which is hardly ever to be seen in the ♂. Finally, the outer margin of the fore-wings in the ♀ is slightly more curved than in the ♂.

VARIATION.—This species, even more than the preceding one, is a native of Asia rather than Europe. In its very limited European habitat it presents little or no variation worth mentioning, and even considering those specimens coming from Asia Minor, the result is the same. The usual minor variations are not uncommon, but do not in any way alter the general appearance of the species. On the upperside the marginal row seems to be the least stable, but it never seems to be wholly wanting. The ♀ varies most in regard to the amount of white suffusion on the fore-wings; in the ♂, variation of this feature seems to be only on the line of increase, rendering the inner discal spot invisible. The spots of the median row vary a little, spot 6 (always by far the smallest) is sometimes quite lost in either sex. The discoidal lunules, too, may be of very different sizes, and also the discal spot, but on the whole the markings of the upperside retain their characteristic appearance with marked constancy. On the underside the tendency in the ♀ to develop a break in the median band, owing to the loss of the spot between nervures 6 and 7, has been already commented on. Specimens in which the spot is very small are not uncommon, but the extreme form such as is shown on Plate LIV, fig. 8, in which it is obsolete, is much less plentiful. The ground-colour of the hind-wings is apparently very constant, as is the slightly darker shade in the ♀.

DATE OF EMERGENCE AND DURATION OF FLIGHT PERIOD. The species is but poorly represented in most collections, and little or no first-hand data are available on either the date of emergence or the duration of the flight period. June and July are given by some authors, but no further details. This deplorable state of affairs is largely due to the great bulk of specimens in collections having come from dealers, and being practically without data. Mabille apparently encountered the same blank, for he does not mention the flight period of the species at all in his section of Seitz's work. Graves records it in early May near Damascus.

DISTRIBUTION.—As regards the distribution of *phlomidis* in Europe, there is little to be said. It apparently only enters Europe in Greece, though it quite possibly might be found in southern Bulgaria. It occurs on the southern shores of the Sea of Marmora (Dimetoka, Warren coll.), and is widely distributed in Asia Minor (Amasia, etc., Reverdin) and Persia, and extends far into Central Asia (Ferghana, Mabille).

The only European record I have been able to find is:

Greece.—Parnassus (British Museum coll.).

Genus **SLOPERIA**, Tutt.

STRUCTURAL CHARACTERISTICS.—Harpe, strongly developed; long; extending to distal extremity of clasp; terminating on proximal edge of cuiller; without style or antistyle. 10th sternite partially developed, not united ventrally.

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Plates 4C Jacru s J N Cark others J Iuan

Genera *Powellia Sloperia* and *Tuttia* male armatures

1 *P phlomidis.* 4 *T tessellum*

2 *S proto* 5

3 *T tessellum* 6 ssp *nomas*

Superficial Characteristics.—Brownish-black species with white spots on upperside: outer row of spots fore-wing present, strongly developed or very faint; median row incomplete, 5th and 6th spots wanting; discal spot nearer to discoidal lunule than median row. Outer edge of central spot of median band, underside, straight or concave, not united with the apex of spot 5 of marginal row.

Sloperia proto, Esper. (Pl. LVI.)

Identification.—*Genitalia.* (Pl. LV, fig. 2.) Uncus long and slender; lateral apophyses two broad processes, their dorsal and ventral edges parallel and their distal extremities bluntly pointed. Clasp more or less oval. The harpe expands gradually in its distal half, reaching its greatest breadth at the point where it starts the final curve downwards towards the cuiller, and then gradually tapering off to its termination at the point of contact with the latter process. The greatest breadth of the clasp is attained in its median area, and is only slightly reduced at the distal extremity. The cuiller, which extends for half the length of the clasp, terminates in a forked manner, its dorsal elevation deeply concave, giving rise to two broad prongs, between which rests the point of the harpe. The distal prong is pointed, the proximal one broader and rounded, both bearing numerous spines on their extremities. The ventral plate is approximately equal in size to the cuiller.

The armature of *proto* is very distinct, only one other species of the genus being at all similar, i.e. *mohammed* (Pl. VIII, fig. 1). In this species it will be seen that the form of the clasp is on similar lines, but it decreases in width towards its termination more rapidly than in *proto*. The terminal prongs of the cuiller are also different, the proximal one being nearly twice as broad as in *proto*, while the harpe increases in width towards its termination, reaching its greatest development at the point of contact with the cuiller, being very strikingly different at this point to the somewhat pointed termination characteristic of *proto*. The lateral apophyses are also quite distinct, being narrower and longer than in *proto*, and having their dorsal edge concave. In the photograph of *proto* the lateral apophyses are seen as a dark elongated mass between the harpe and the aedoeagus, this is caused by displacement in the mounting of the specimen. The lateral apophyses are set lower down in *proto* than is usual, and are only very delicately attached by a scarcely chitinised membrane to the main body, so that it is extremely difficult (? impossible) to avoid a certain amount of displacement in preparing and mounting a specimen.

General features.—Size, 30–35 mm., exceptionally 38 mm. *Upperside:*—Fore-wings: discoidal series incomplete, discoidal lunule alone present, median row incomplete, 5th and 6th spots wanting, remaining spots approximately equal in size and more or less square in form; outer row very faint, but usually discernible; discal spot extremely narrow, but sharply defined; subcostal spots wanting. Hind-wings: one basal spot, the 2nd, present; median band incomplete, 3rd, 4th, 5th and 6th spots usually present; marginal row present, usually better defined than the outer row on the fore-wings. Inner half of wings thickly covered with long yellowish hairs, somewhat obscuring the light spots. *Underside:*—Fore-wings: discoidal lunule and first four spots of median row standing out clearly against a dark background; discal spot distinct on its inner edge, but merging into a suffusion of yellowish scales on its outer edge, which suffusion also surrounds the three apical spots of the median row, more or less covers the last four spots of the outer row, and extends all over the basal area of the wings and along the costa. Hind-wings: two basal spots present, the 2nd and 3rd, the latter much the larger; median band complete, outer edge of central spot concave; marginal row composed of narrow V-shaped spots, complete and distinct. Ground-colour, various shades of ochre, yellowish-green and dull pinkish-red, of no great density, the dark subscaling

showing through over the whole area; nervures of a lighter colour, but not very prominent.

COMPARISON WITH THE OTHER SPECIES OF THE GENUS.—*Proto* being the only European member of the genus, any very detailed comparison with the other species is unnecessary, but a few points of difference between it and some of them may be of interest. *Mohammed* is the species which is most similar to *proto*, but the latter can be distinguished by the very faint marginal series of spots on the upperside; in *mohammed* these are large and very clear and distinct. The following notes by Powell, who has had great experience of both species, set out the distinguishing features of *mohammed* very clearly. "In *mohammed* the apex of the fore-wing is sharper; the white spots are brighter on the upperside; the outer margin is much more deeply indented with white—especially on the hind-wing—the alternating black lines carried through to the outer edge of the fringe, being consequently longer than in *proto* and very conspicuous. On the underside the white spots have a brilliant, porcelain-like surface and they are sharply outlined in black on the outer and inner edges (with the exception of a few of the spots)."

From *poggei* and its allies, *ioan* and *lutulentus*, *proto* is easily distinguished by the position of the 3rd basal spot and the last spot of the median band on the underside. In the former species these spots are moved outwards, so that the 3rd basal spot is well in advance of the 2nd, and is almost touching the median band, while the last spot of the latter is moved out of line with the spots which immediately precede it. In *proto* the basal spots are in line with each other, as is the last spot of the median band with those which precede it. The remaining species are quite distinct and need not be mentioned.

SEXUAL DIMORPHISM.—In the ♂ the upperside of the fore-wings is thickly covered with yellowish superscaling, sometimes with a greenish tinge, and similarly coloured hairs are more or less numerous on the inner half of the hind-wings. In the ♀ all this superscaling is greatly reduced, especially on the fore-wings, which are occasionally without it. The light spots on the upper side of the ♂ are yellowish in colour, while in the ♀ they are white. The ♂ further has a well-developed costal fold on the fore-wings, which the ♀ of course has not.

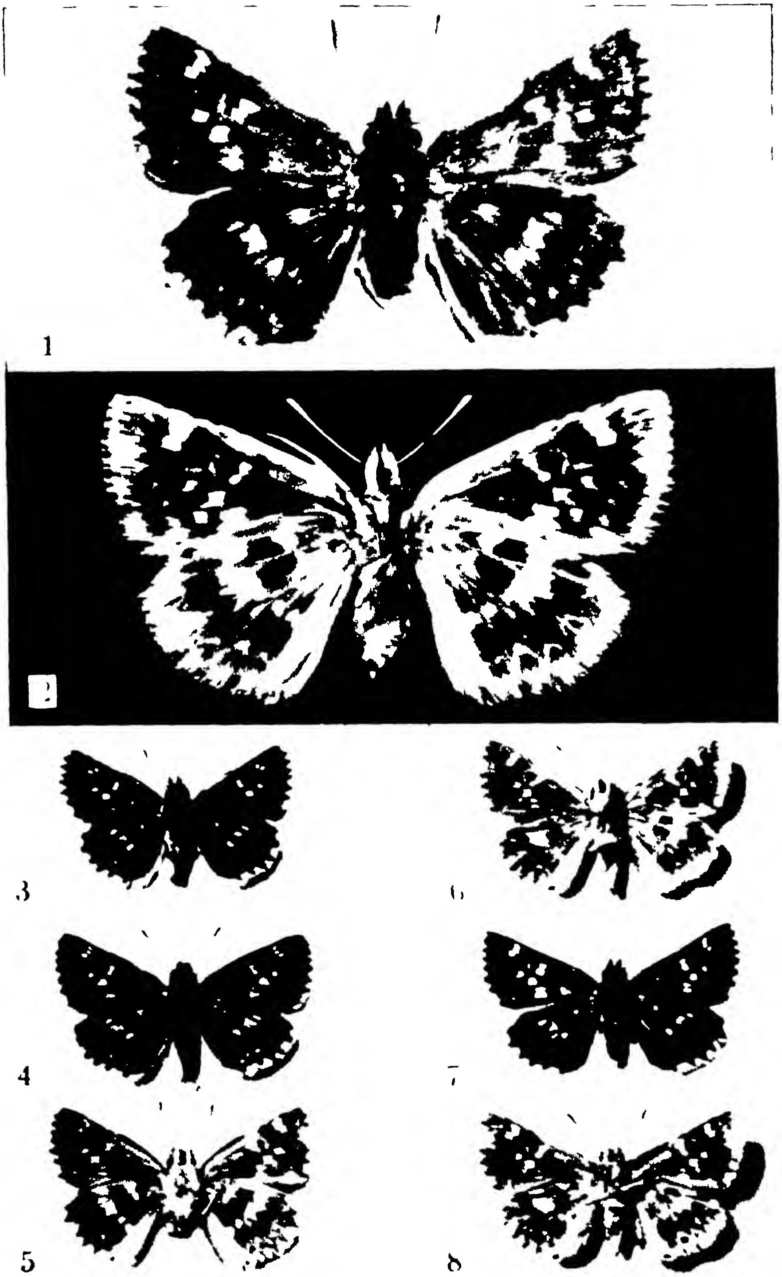
VARIATION.—The species is not a variable one, and even in such widely separated localities as Sarepta and Granada it seems to occur in exactly similar form. Nothing in the nature of a subspecies seems to exist in Europe, and the minor variations are by no means abundant. Occasional very large specimens occur aberrationally in Europe, but racially in the Atlas Mountains. The race does not differ from *proto* except in size, but it seems worthy of notice, especially in view of the scarcity of racial variation in Europe.

race **gigas**, Vty.

Large specimens, 38–40 mm., otherwise similar to the type. Abundant at Azrou in the Middle-Atlas, Morocco (Powell), where it occurs with typical-sized specimens.

race **aragonensis**, Sagarra.

This race, the type specimens of which came from Albarracin, differs from type *proto* in the pale colour of the underside of the fore-wings, which are suffused with white scales to such an extent that the dark ground-colour is obscured, and the marginal row of white spots also. The white markings of



S [illegible]

1 Upperside [illegible] Un[illegible]

N[illegible] s[illegible]

3 Cuenca [illegible] 6 [illegible] Mon[illegible]

4 Andalusia [illegible]

5 Rosan[illegible] (Ht[illegible] Alpes) [illegible] 8 G[illegible]

the underside of the hind-wings are broader than the corresponding markings of the type, and less sharply defined.

race nigrita, Vty.

This race is described as being of very small size, " 20 to 25 mm. from tip to tip," with the upperside a uniform deep black tinge, the marginal row of spots nearly obscured, and all the white markings reduced. The underside of the hind-wings pale yellow, mixed with black scales, tending in some specimens to be slightly greenish.

Habitat :—Cuenca in New Castile : the type also occurs in this locality (see fig. 3, Pl. LVI). It must be noted that the measurements quoted from the original description are taken from " tip to tip," and therefore cannot be compared with the other measurements given, and also leave the exact size of the type specimens doubtful. The remarkable feature of this race is the absence of the light superscaling on the upperside of the ♂.

Turning to the aberrational forms, the most marked variation noted is in connection with the marginal series on the upperside. There are one or two specimens in the British Museum collection without this row of spots on the hind-wings; this gives these specimens a darker look than usual, there being no white between the median band and the fringes. Intermediate specimens with only two or three spots remaining are fairly common. The corresponding spots of the fore-wings, though normally less distinct than those on the hind-wings, are apparently never entirely wanting, a close inspection revealing their shadowy presence.

The spots of the median row upperside are occasionally reduced in size, and the 1st and 2nd may even be lost, but this is rare and the reduction is not very great. On the whole, the ground-colour of the underside of the hind-wings is the most variable feature of the species, passing from plain ochreous to a greenish-yellow and a variety of reddish shades. The greenest specimens I have seen came from Andalusia, some of the reddest from French localities, and plain ochreous ones occur everywhere. So far as one can tell, however, the colour variations are not connected in any special manner with the region of habitat, being extensively variable in every locality.*

Date of Emergence and Duration of Flight Period.—*Proto* is almost certainly a single-brooded species, but the duration of the flight period is very remarkable. We have authentic records of the capture of *proto* in May, June, July, August and September in Spain, and in June, July, August and September in France, while in a note in the *Entomologist's Record*, vol. xxxv, the emergence of bred specimens in England is recorded as late as October 28th, by A. Simmons. The comparison of such records would at first appear to imply that the species was double-brooded at the least, but fortunately we are in possession of more data on the subject than is often the case. When the dates of capture from any one locality are examined, we find that in Europe the duration of the flight period does not seem to exceed twelve weeks. The actual dates covering the longest period which I have been able to find are : in Spain, May 26th and August 1st, at Algeciras and Gibraltar (Tring Museum coll.), at Albarracin, June to September (Sagarra); and in France, at Septîmes in June (Foulquier, etc.) and September 12th (Reverdin). Thus it will be seen that where it occurs in May we have no record of it existing after early August, while in France there is no record of its appearance before June (generally late in the month), but it lasts into September. July is unquestionably the month of its greatest abundance in France. All this points very strongly to one brood, a supposition which

* See Note (5), p. 162.

becomes a certainty, when viewed in the light of the following note on the species in Africa, by Powell.

"In North Africa I have taken *proto* in May, June, July, September and rarely in October. I am strongly inclined to think, however, that there is only one brood in North Africa, but that a few laggard larvae, instead of pupating to produce the May–June emergence, are overtaken by the summer heat and become torpid, not pupating until July or August. The summer specimens are never abundant. In Algeria and Morocco, I have had larvae full-fed by the end of May, which without any further feeding did not pupate until August, the imagines emerging in September at the same time as *P. mohammed*, a species I have never met with in the spring. At Azrou, in the Middle-Atlas of Morocco, *proto* is common in late May and June; there the larva feeds on *Phlomis crinita* and *P. bovei*; in Algeria I have found the larva on *P. herba-venti* and *P. crinita*. The larva of *mohammed* is common locally on the same plants in May and June, but it always aestivates, not pupating until August."

There does not seem much reason to suppose the larval habits of the species differ in one locality from another, especially as in all the districts inhabited by *proto* in Europe a decidedly hot summer season is normal. There can be little doubt therefore that late July, August and September specimens are the result of aestivating larvae, and not the progeny of the May and June specimens.

Distribution.—The distribution of *proto* is remarkable; it occurs over a wide area in a very scattered manner, ranging from Spain to Turkestan, and from Morocco to Sarepta. In Europe it is widely distributed in south-eastern Spain, and occurs along the coast of southern France extending as far north as Rosans in the Ht. Alpes; it is not found in Italy, but it occurs in Sicily, Greece and south-eastern Russia. I have not found any record of its occurrence in the northern Balkans or Hungary.

European localities :—

France.—Rosans (Warren); Marseilles (Tring Museum coll., Oberthur); neighbourhood of Montpellier (Oberthur); Septimes (Powell, Reverdin); Plan d'Aups, Sainte Baume Range (Powell); Allauch; Aix (Provence); Saint-Pons (Foulquier); Les Montagnets (Gard); Vaucluse (Reverdin); Riviera (British Museum coll.).

Greece.—Greece (British Museum coll.).

Italy.—Unknown on the mainland (Verity).

Sicily: Sicily (Verity); Taormina (Chapman).

Russia.—Sarepta (Sheldon, British Museum coll.).

Spain.—Lanjaron; Granada; St. Roque; Tragacete (British Museum coll.); Albarracin (Sheldon, British Museum coll.); Gibraltar; Algeciras (Tring Museum coll.); Cuenca; Catalonia; Andalusia (Reverdin); Sta. Coloma de Gramanent; Besós; Montserrat; Calella; Vallcarca; Moncada (Sagarra).

Genus **TUTTIA**, Warren.

Structural Characteristics.—Harpe very slightly developed; short; not extending to distal extremity of clasp; terminating before proximal edge of cuiller; without style or antistyle. 10th sternite wanting.

(This genus is further distinguished by the presence of a pair of very strong chitinous processes on each side of the aedoeagus (though apparently not attached to it) roughly wing-shaped, developed from the penis-sheath; unknown in any other palaearctic genus.)

Superficial Characteristics.—Brownish-black species, with white spots on the upperside, which is thinly, but broadly dusted with greenish superscaling;

outer row of spots fore-wing complete, strongly but not sharply developed, equidistant from median row and margin of wing; median row incomplete; discal spot almost half-way between discoidal lunule and median row.

Tuttia tessellum, Hübner. (Pls. LVII and LVIII.)

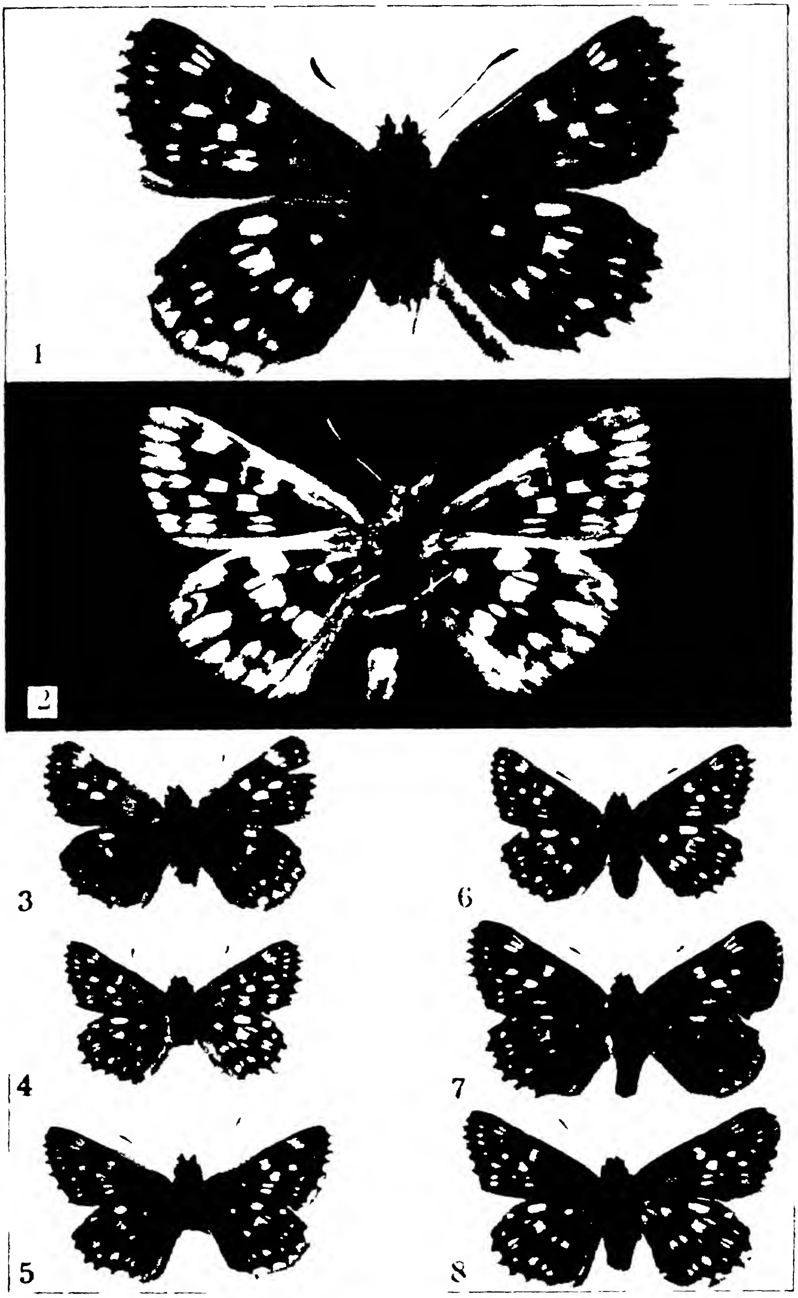
IDENTIFICATION.—*Genitalia.* (Pl. LV, figs. 3–6.) Uncus long and slender; aedoeagus variable, proximal end sometimes tapering, sometimes expanding. Clasp very variable; the harpe, always ill-developed, is slightly larger at its termination. The portion which rises vertically from the cuiller assumes three main forms: (1) Pl. LV, fig. 4, expanding as it nears the cuiller, terminating somewhat club-shaped and rounded off; (2) Pl. LV, fig. 5, practically equal in width to its termination and not rounded; (3) Pl. LV, fig. 3, expanding suddenly at its termination into a rough knob. Very occasionally it is developed as in s.-sp. *nomas*, Pl. LV, fig. 6, reduced to nothing at the dorso-distal angle, and broadening out in a regular slant to the full width, which continues to the termination. It may be noted that this form, though the most usual in *nomas*, is not invariable, and specimens occur in which the harpe terminates as in *tessellum*, like fig. 5. The cuiller of *tessellum* is as variable as the harpe. Beginning very narrow, its sides diverge rapidly as they rise to the broad dorsal termination, which may be almost flat with one proximal tooth, or strongly concave with two teeth, one proximal and the other distal. The actual height of the cuiller varies in nearly every specimen: it may be only just half the total breadth of the clasp, or nearly three-quarters, the former being similar to *nomas*, as will be seen if figs. 5 and 6 are compared (Pl. LV). The length of the terminal teeth of the cuiller is also variable. Usually they are approximately equal, but the proximal one tends to be the longer, though the reverse can be the case, as in fig. 3, Pl. LV.

From the distal edge to the cuiller there extends a flap-like piece, the outer edge of which is serrated. This flap can be either folded back on the cuiller, or extended, as the case may be, and accordingly alters the look of the cuiller considerably. In figs. 5 and 6, Pl. LV, it is seen extended; in fig. 4 partly so; in fig. 3 it is folded back. The ventral plate is often very extended, and always much broader than the cuiller at the point of junction with the latter. The wing-like processes which spring from the penis-sheath are apparently also of a variable nature, but it is difficult to judge, as they can seldom be mounted in exactly the same position in any two specimens. In the photograph of *nomas* they appear to be of very different form from fig. 5 (Pl. LV), but other mounts of *nomas* and *tessellum* give one the formations exactly reversed. In unmounted specimens no such decided difference is observable, and I feel fairly sure that any specimen could be mounted to resemble either form, if the operator were skilful enough. The teeth on the edges are variable, and do not always appear to be located on the same edge; and in a few specimens there seem to be teeth on two edges. In fig. 5 the tips of teeth are visible on the lower edge of the upper wing. It seems probable that in reality the teeth are situated dorsally on a slightly expanded and rounded object, and that the varying shapes of the structures and teeth, as they appear when mounted, are the result of pressure and consequent flattening in the mounting, and that the teeth, when the structure is flattened, may appear on either one side or the other, and in rarer cases may even get divided so as to appear on both sides. The narrower form of the whole structure, in these rare cases, further supports this theory.

Among European Hesperids, *tessellum* alone has these remarkable wing-like structures, which render the genitalia unmistakable; the other two species of the genus, *gigas* and *nobilis* (Pl. IX, figs. 2 and 3), can be distinguished from *tessellum* by the form of the clasp, and the length and equal width of the upright, terminal part of the cuiller. The same points of course also distinguish *nomas* from *gigas* and *nobilis*.

General features.—Size variable, ranges in the ♂ from 30–36 mm., exceptionally 42 mm., and from 34–44 mm. in the ♀. The whole of the upperside is dusted evenly, though not very densely, with greenish scaling. *Upperside*:—Fore-wings: discoidal series represented by the discoidal lunule, which is broad; median row incomplete, 5th and 6th spots wanting, 7th, 8th and 9th more or less rectangular, 3rd and 4th somewhat square and usually the largest of the series, 1st and 2nd spots often broken, producing two more small spots between them and the outer row, which is complete, consisting of eight good-sized spots, not sharply outlined; discal spot a mere line, but very sharp and clear. Hind-wings: one basal spot visible, the 2nd; median band complete, but all the spots well separated; marginal row complete, 5th spot usually divided into two. *Underside*:—Fore-wings: all the markings as on the upperside, but often broader, and the outer row more suffused. Hind-wings: only one basal spot, the 2nd, but it usually stands out clearly surrounded by the ground-colour; median band complete; marginal row complete, but variable as to the size of the spots, which usually are not solidly united to the margin of the wing, but enclose a more or less pronounced row of lunules of the ground-colour. The latter varies from brownish-yellow, often with a dull grey tone, to bright greenish yellow. Nervures scarcely visible, as a rule.

COMPARISON WITH *FAVRIA CRIBRELLUM*.—As *tessellum* is the only European species of the genus, and the other two species do not resemble it at all closely, we may turn immediately to a comparison of *tessellum* and *F. cribrellum*. The latter, superficially, is much more similar to *tessellum* than are the other species of *Tuttia*. *Tessellum* is on the average a much larger species, but certain small specimens of the ♂ are very close to *cribrellum* in size. *Tessellum* differs from the latter on the upperside by the smaller size of the white markings, all the spots being well separated, especially those of the median band. In *cribrellum* the latter spots are all well developed and only divided by the nervures marked in black; in *tessellum* they stand well apart from each other. Further, the median row on the fore-wings is usually without spots 5 and 6 in *tessellum*, and with them in *cribrellum*, but this cannot be altogether depended on for identification, as specimens of *tessellum* occur with them and of *cribrellum* without. On the whole, the small size and large spots give *cribrellum* a much whiter appearance on the upperside; on the underside one gets the same impression of whiteness, especially on the hind-wings. In *tessellum* there is generally more ground-colour visible than white on the underside, and on the hind-wings the ground-colour on the inside of the median band does not extend beyond nervure 8. This is the most constant and reliable point of distinction between the two species. In *cribrellum* the ground-colour on the inside of the median band always extends beyond nervure 8, sometimes only in the shape of a small spot, but always present, to a greater or less extent. A further distinctive feature of the underside of the hind-wings is, that in *tessellum* the marginal row of spots always encloses a series of lunules of the ground-colour between themselves and the margin. These lunules are sometimes so large as to separate completely the marginal row from the margin, at other times they are so reduced as only to appear as dark shades in the centres of the spots or on the nervures between them, which retains the spots, as spots, and prevents them uniting into a solid band. In *cribrellum* the marginal row usually does form a continuous band round the margin of the wing, completely obscuring any ground-colour next the margin. The latter form can always be accepted as certainly *cribrellum*, but unfortunately the former, though typical of *tessellum*, cannot be completely relied on, as it occurs occasionally in *cribrellum* (see fig. 5, Pl. LX). The specimen figured, though similar to *tessellum* in the character of the marginal



[illegible]

Tuttia tessellum

1 Upperside × 2

2 Underside × 2 ab. *cribrelloides*

Natural size

3	Aksu Eastern Turkestan	6	Uralsk
4	Uralsk	7	Altai
5	Altai	8	West Siberia

row, can immediately be recognised as *cribrellum* by the spot of ground-colour above nervure 8.

The position of the 2nd spot of the median band underside is also a useful feature. In *tessellum* this spot is on a line with the first one (*i.e.* the spot next the inner margin) on their inner edges; in *cribrellum*, the 2nd spot projects inwards beyond the first by, sometimes, half its own length. Finally, in *tessellum*, the nervures on the underside of the hind-wings are scarcely visible, usually covered by the ground-colour, while in *cribrellum* they are outlined in a paler colour than the ground-colour, often quite white. In one or two of the photographs on Plate LVIII, especially figs. 5 and 7, it looks as if the nervures in *tessellum* were conspicuously light. This is only the result of the nervures standing somewhat above the level of the plane of the wing, and in consequence catching the light more than the background; they were exactly the same colour as the background, and very different from the fine white rays to be seen in *cribrellum*.

Sexual Dimorphism.—The sexes differ considerably in *tessellum*. On the average, the ♀ is much the larger, as is shown by the sizes quoted before, though occasional specimens of the ♂ are nearly equal to the largest ♀. The greenish superscaling, which is such a feature of the species, is somewhat denser in most ♀s and often greener in colour. The white spotting often appears heavier on the ♀s, but this is perhaps to be attributed to the increased size of the spots, which is proportionate to the larger size of the specimen. The underside of the ♀ usually has a more washed-out appearance, the marginal row of spots being usually more blurred and showing a greater tendency to unite with the margin of the wing. The ♂ has a well-developed costal fold on the fore-wings, which the ♀ has not.

Variation.—The variation of *tessellum* is interesting in many ways. The most striking varietal form is of course the subspecies *nomas*. This subspecies has been so often included in the European list that it seems best to include it here, though I am quite sure that it does not occur in Europe.

s.-sp. **nomas,** Led. (Pl. LVIII, figs. 9–12.)

Upperside similar to *tessellum*, underside hind-wings entirely suffused with yellowish-white, which partially obscures the markings of the fore-wings also.

Genitalia. (Pl. LV, fig. 6.) The genitalia of this remarkable subspecies are so different from many *tessellum*, that at one time Reverdin was led to suppose *nomas* to be a distinct species. The subsequent discovery, however, that specimens of *tessellum* with the genitalia of *nomas* are nearly as numerous as the others which are different from it, obliged him to reconsider his opinion. The chief points of difference between the genitalia of this subspecies and the most usual form of *tessellum* have been already mentioned (*i.e.* the form of the cuiller and its terminal teeth, and the distal part of the harpe), so they need no further comment here.

Nomas is abundant in many parts of Asia Minor, and according to Mabille it is also found in the Altai and Western China, but I have not been able to find any confirmation of its occurrence in those districts. Should *nomas* occur in Western China, it is quite possible that it may be found in company with *tessellum*, which is certainly widely distributed in Central Asia. If this were so, in those localities *nomas* would not be a subspecies, but there seems no reason to doubt that in Asia Minor it is, and that it has entirely superseded *tessellum*. The density of the white suffusion on the hind-wings varies considerably; in some specimens the other markings of the wings show through fairly clearly, but the

extent of the suffusion is always the same. On the fore-wings it is occasionally almost absent. *Nomas* is the only subspecific form known.

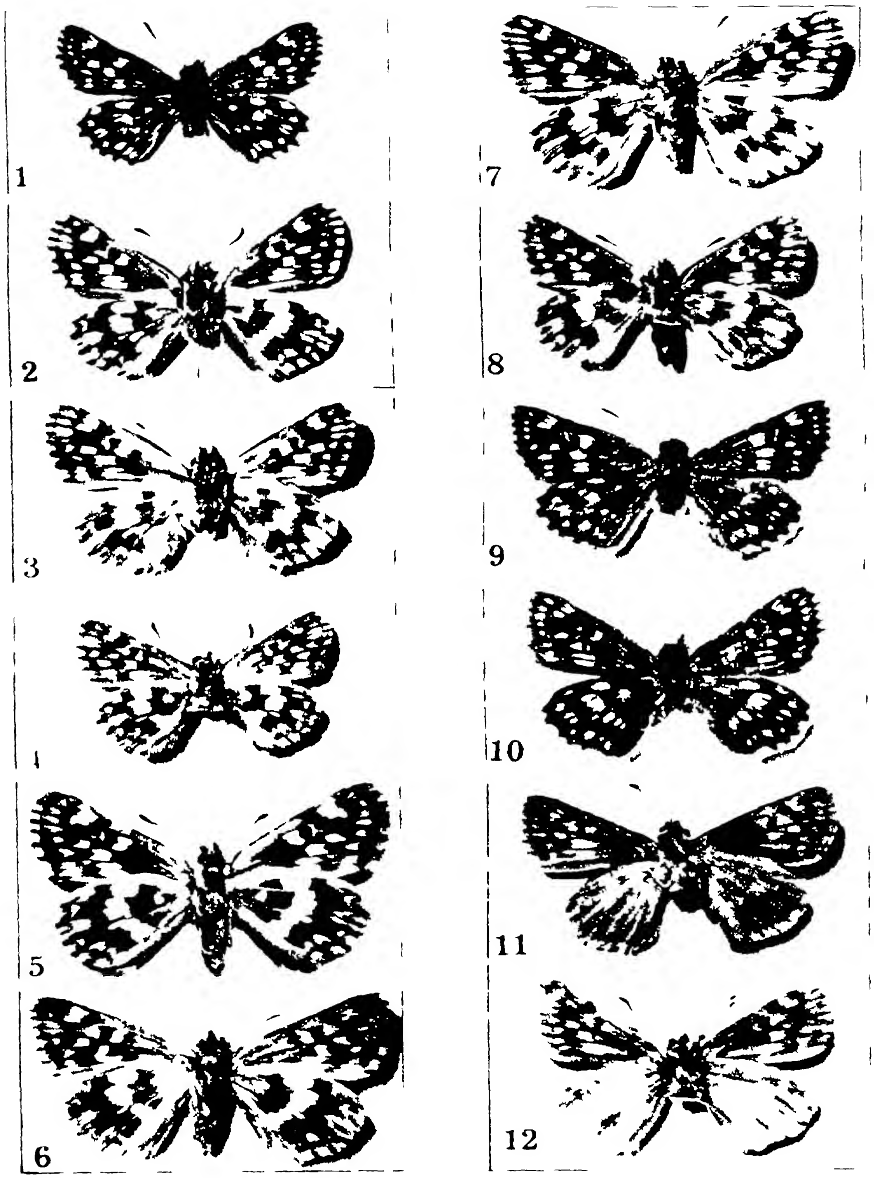
In the minor variations, in addition to numerous aberrational forms on the lines of increase or decrease of markings, we find fairly frequently a certain combination of features, which suggest the existence of a distinctly characterised race. This, however, is not the case. The features in question are the following: (1) small size; (2) bright yellow ground-colour underside hind-wings; (3) increase of white markings on upperside; (4) loss of sharpness of outline of white markings of underside. The occurrence of these four characteristics in one individual results in a very considerable likeness to *cribrellum*. Were these characters constantly associated, we should undoubtedly have a very distinct race, but they are not; specimens showing the four converse characteristics (*i.e.* large size, dull brownish or greyish-green ground-colour underside hind-wing, restricted white markings on upperside, sharply and clearly defined white markings on underside) are typical of *tessellum*. It is no uncommon thing to find a specimen in which any one of the first group of characters may appear in connection with three of those of the 2nd group; or other specimens which combine two characters of each group, etc. It is obvious, therefore, that the forms which can be produced by combinations of the units of these two groups of characters are very numerous, and, judging from the available specimens, it seems fairly certain that every possible combination exists. It must also be remembered that the characters mentioned are not really definable characters, as I have set them down, for in each group only the extremes are referred to; they are really non-definable characters, and pass imperceptibly from any one form to the extreme opposite. In spite of the occurrence, therefore, of certain very distinct-looking specimens suggestive of a definable race, in reality no such race exists. There is, however, little or no doubt that these varying quantities are more or less opposing one another, and that sooner or later a definable race will emerge, possibly several races. It may be useful to describe the form which is at present the most pronounced.

ab. **cribrelloides,** nov. (Pl. LVIII, figs. 1 and 4.)

Small specimens, ♂ 30–32 mm., ♀ 34–36 mm., with large fully-developed white spots on the upperside, and with the marginal series of spots on the underside tending to unite with each other and the margins of the wings; ground-colour of the underside of the hind-wings bright yellow with a slight green tinge.

This description is taken from specimens showing the extremes of each of the previously described characteristics of the first group, *i.e.* specimens as far removed from the type as is possible in this line of variation. Specimens exactly similar will be scarce, others, more or less similar, of fairly frequent occurrence.

Some idea as to the variation in size of both sexes can be gathered from our plates, many of the specimens shown are not of European origin, but the variation in this respect is just as great in Europe as in Asia. On the upperside the spots of the outer row are the most liable to variation, but no specimen quite without them seems to have been recorded in Europe. The median series in both wings shows frequent variation too. On the fore-wings this is chiefly on the line of increase, while on the hind-wings it is the opposite, the spots being reduced in size or altogether absent. The extreme of the latter variation is reached in the form which Mabille has called *nigricans*. So far this aberration has not been recorded in Europe, but, as specimens with greatly reduced white markings are found, it is quite probable that the extreme form will also occur.



Tuttia tessellum

Natural size

1	ab *cribrelloides* Sarepta	5	Altai
2	Aksu Eastern Turkestan	6	
3	West Siberia	7	West Siberia
4	ab *cribrelloides* Uralsk	8	Uralsk

9–12 ssp *nomas* Asia Minor

ab. **nigricans,** Mab.

The type specimen of this aberration was a ♀, which is remarkable seeing that the ♂ as a rule shows a far greater tendency to melanism. It was described as being black on the upperside, the fore-wings with only 3 white spots, *i.e.* the discoidal lunule and the 3rd and 4th spots of the median row; the spots on the hind-wings reduced in size, some wanting.

Date of Emergence and Duration of Flight Period.—The available data on the flight period of *tessellum* amount to little or nothing. Considering what a fine species it is, apparently not scarce where it occurs, one would have expected more information to be available. Kirby states (*Butts. of Europe*) that it is found in May and August, presumably two broods. Kane says the same. I have only been able to find two August specimens, the majority of such specimens as are labelled being June examples, and there are some labelled July in the British Museum collection. Sheldon and Jones recorded *tessellum* at Sarepta from May 27th–June 17th, 1914, and the specimens in the British Museum collection labelled July are from Sarepta too. Other dates collected are: June 26th, Salonika (British Museum coll.); Uralsk, June 5th, 1907 (Wheeler coll.); Uralsk, June 10th, 1907, August 2nd, 1907, and August 10th, 1907 (Chapman coll.); the last three taken by Max Bartel, who, one must gratefully acknowledge, almost alone among dealers, took the trouble to supply accurate data with the specimens he sold. A specimen of the s.-sp. *nomas* was labelled " Zahalta 5000 ft. V. 05." (Chapman coll.). Bartel's specimens from Uralsk seem to confirm the supposition that *tessellum* is double-brooded. On the other hand, the July specimens from Sarepta are difficult to account for. As there is no day of the month mentioned, however, one must almost disregard these specimens. We know that *tessellum* occurs at Sarepta as early as May 27th, and possibly before that date; a specimen taken in the first few days of July might still easily belong to the spring emergence, one taken during the last few days might equally well be a summer emergence. The fact that *nomas* can emerge at 5000 ft. in May is remarkable, but of course the locality is so far south of Sarepta that latitude probably counterbalances altitude. So far as our meagre data go, it would seem that *tessellum* is double-brooded. Bartel's specimens are stronger evidence than they would seem to be at first sight, for in addition to the above-mentioned specimens, I have seen others of Bartel's taken the same year, but all June specimens. The specimen in the Wheeler collection is also of 1907, and most probably Bartel's too. It is obvious that Bartel was in the Uralsk district all that summer, but he apparently took no *tessellum* in July. This cannot be attributed to his having got all he required of the species in June, for we know he took some in August. It seems safe to infer that there were none in July, and that the August specimens must have been a second emergence.

As to the duration of the flight period, it is evident that the spring brood usually lasts from late May to late June. The duration of the summer brood remains entirely unknown.

Distribution.—*Tessellum* is a widely distributed species in Asia, extending to Eastern Turkestan, Tibet and the west of China. In Europe it seems confined to south-eastern Russia and Greece.

European localities :—

Greece.—Ferezli; Salonika (British Museum coll.).
Russia.—Sarepta (British Museum coll., Sheldon. Jones, etc.).

Genus **FAVRIA**, Tutt.

STRUCTURAL CHARACTERISTICS.—Harpe strongly developed; **short**; **not** extending to distal extremity of clasp; terminating on proximal edge of cuiller; antistyle present, strongly developed and highly specialised; style wanting. 10th sternite partially developed, united ventrally.

SUPERFICIAL CHARACTERISTICS.—Brownish-black species, with white spots on the upperside, which is thinly dusted with greyish-green superscaling on the basal area of the wings only; outer row of spots, fore-wings, complete and very strongly developed, equidistant from the median row and margin of the wing; median row complete; discal spot on upperside wanting, or very faintly marked.

Favria cribrellum, Eversmann. (Pl. LX.)

IDENTIFICATION.—*Genitalia*. (Pl. LIX.) The genitalia of this species are of a highly specialised nature, and form an extraordinary contrast when compared with those organs in the last genus, to some of which *cribrellum* is superficially so similar. The lateral apophyses of the 10th sternite are somewhat suggestive of the formation of those processes in *H. onopordi*, consisting of two prongs, but broader, and not smooth as in the latter, but studded with tiny excrescences and spines. The two prongs are united ventrally by a thinly chitinised membrane, the chitin being strongest across the base. The clasp is remarkable for the extraordinary structure developed from the ventral aspect of the harpe. After careful examination, I think we cannot do otherwise than call this structure the antistyle, although it is larger than the rest of the harpe and there is no style. Still, its position and construction are such that no doubt can be entertained that it is homologous with the antistyle of the other Hesperid species. It is somewhat rectangular in form, the ventral edge slightly concave, and the proximal end rounded, the whole covered with short pointed excrescences. The harpe, apart from the antistyle, is of more or less regular width throughout, but in its proximal half, just before, and at, the proximal end of the antistyle, it has the appearance of having the lower edge folded up, producing a curved excrescence which unites with the corner of the antistyle and is completely covered with very long spines that are all set in one direction. This spined excrescence is unquestionably in every respect a formation absolutely homologous with the stylifer of other species, although it is developed at the reverse end of the harpe. The antistyle is one with it, and there is no visible line of union between the two, as there is between the distal end of the antistyle and the harpe. The cuiller is broad and very fully developed, terminating in a sharp point at its summit. The ventral plate has a straight upper edge, and tapers to its junction with the cuiller. The aedoeagus is as remarkable as the other parts, with its unique internal armament of spines.

The features of the clasp and aedoeagus are unapproached by any other known Palaearctic species. One can only wonder how such an absolutely isolated species can have been left for so long in the same genus as *tessellum*, etc., especially as the latter further differs from *cribrellum* by the loss of the 10th sternite and the presence of the wing-like processes of the penis-sheath. It is a striking object-lesson on the futility of attempting any classification or grouping of Hesperid species based on superficial or secondary sexual characters.

General features.—Size, 28–36 mm. in both sexes. *Upperside:*—Fore-wings: discoidal series incomplete, composed of 1st and 2nd spots and the discoidal lunule which is more or less square; median row complete; outer row complete, and very strongly developed; discal spot wanting; subcostal spots variable, traces of one or two often visible, frequently all absent. It is questionable whether the first

2

Genus *F*[illegible] male armature

1 *F.* [illegible] With clasp and [illegible] removed
Right clasp
3 Aedeagus

two large spots on the inner margin of the wing, those nearest the base, should not be taken as belonging to the median row, as in *tessellum*. But in this case they are, on the average, decidedly nearer the base of the wing, and the two spots outside them are both larger and better formed, and of fairly frequent occurrence in the ♂. This seems to justify one retaining them in the discoidal series, which is also the least confusing arrangement. Hind-wings: one basal spot, the 2nd, present; median band complete, composed of spots only separated by the width of the nervures; marginal row complete and strongly developed. *Underside*:—Fore-wings: outer row more or less united to the margin, often entirely so, forming a continuous antemarginal band; discal spot present, very narrow; other markings as on upperside. Hind-wings: one basal spot, the 2nd, more or less visible in a white basal suffusion; median band complete, 2nd spot not in line with the 1st, but moved considerably nearer the base of the wing; marginal row united, forming a complete and broad antemarginal band. Ground-colour of varying shades of yellowish or olive-green, of very even density, nervures finely outlined in white.

NOTE ON THE POSITION OF THE STYLIFER AND ANTISTYLE IN *CRIBRELLUM*, AND THE HOMOLOGY OF THE FORMER WITH THE HARPAL PROCESS IN THE ETHIOPIAN SPECIES *SPIO*.—The development of a stylifer and antistyle situated as in *cribrellum* is of the greatest interest. Were the antistyle removed, we should not have recognised what the stylifer actually was. Its presence in this position in *cribrellum* has solved another problem. The Ethiopian species *spio* (*vindex*) has, as is well known, a remarkable development on the harpe beginning near the proximal end, and bearing a few short, thick spines, which become broader and stronger on its dorsal edge. Chapman, in his notes, suggested that this formation was that which had preceded and evolved into the style, an opinion which was not so far removed from the truth. If we were to remove the antistyle from *cribrellum*, and the long thin spines from its stylifer, there would remain precisely the formation we see in *spio*, but somewhat smaller than, and without the short thick spines of, the latter. Viewed in this light, the puzzling formation in *spio* is plainly seen to be that development which is called the stylifer, situated in the unusual manner we see in *cribrellum*. The antistyle in *spio* has either never developed or else been lost. Chapman at the time he wrote his notes cannot have compared *spio* with *cribrellum*, or he would undoubtedly have perceived the true nature of the harpal structure. We can but admire the remarkable perception which, without the help of this comparison, led him to connect this extraordinary stylifer with a style.

On Plate LIX, fig. 2, the stylifer of *cribrellum* can be made out as a dark extension from the left-hand corner of the dark, rectangular antistyle, and the uppermost long spines of the former can be seen projecting above the dorsal line of the harpe, all directed distad; while the hairs which cover the harpe rise in every direction. The stylifer of *spio* is longer, and extends more than half the length of the harpe, and its upper edge is apparently free, as is the base of the style in so many species. In a paper on the Ethiopian Hesperids (*Trans. Ent. Soc. Lond.*, 1924), L. G. Higgins in his note on the genitalia of *spio* states, "coarsely toothed rounded internal process appearing above upper border"—of clasp. He also figures *spio* showing quite half the stylifer projecting above the dorsal ridge of the clasp. All the illustrations of the genitalia in his paper are outline drawings, representing the outside of the clasp, and give one in consequence little or no idea of the formation of the harpe or cuiller, but so far as one can judge from the drawing of *spio*, the harpe is either deformed, or has got folded down in mounting the specimen, or broken off, probably the latter, for there is no trace of the free terminal portion of the harpe; and the

sharp angle standing up just inside the cuiller, which represents the proximal tooth of the latter, is shown as being level with what should be the dorsal line of the harpe, instead of being below the ventral edge of that structure. This is what causes the stylifer apparently to project above the edge of the harpe, which is not normal to the species. The accompanying diagram shows the typical form of the clasp—the right clasp seen from the inside.

In Reverdin's, Chapman's and my own mounts of *spio*, the position and form of the harpe and stylifer are as seen in the diagram, with the upper teeth of the stylifer just appearing above the harpe, but no more.

Comparison with *Tuttia tessellum*.—The identification of *cribrellum* should never be a matter of much difficulty. The only member of its genus, this very specialised species makes no close approach to any other Hesperid except *tessellum*. The points of difference between the two having already been fully described (see *tessellum*), it is therefore unnecessary to repeat them here.

Sexual Dimorphism—The difference between the sexes is not very great in *cribrellum*. The ground-colour of the upperside of the ♀ is, as a rule, browner than in the ♂, and the slight basal superscaling on the fore-wings is greenish-yellow in the ♀ and grey in the ♂. In the latter, also, the 1st and 2nd spots of the median row on the upperside are usually more pronouncedly marked. In the ♀ the 1st spot is frequently absent. The ♂ is further distinguished by the presence of a small costal fold on the fore-wings.

Variation.—*Cribrellum* on the whole shows but little tendency to variation. Mabille has described one Eastern race, the principal difference in which is the presence of a greyish discal spot. In the more westerly districts nothing like a racial form has been found. The most striking European variation noted is that in which the marginal row of spots on the underside is separated into a series of distinct spots, thus giving the specimen a greater look of *tessellum*. I have seen several specimens of this variety, which is purely aberrational, none of the specimens being quite similar as to the extent to which the spots were separated. In view of the likeness to *tessellum*, it may be well to record such specimens as:

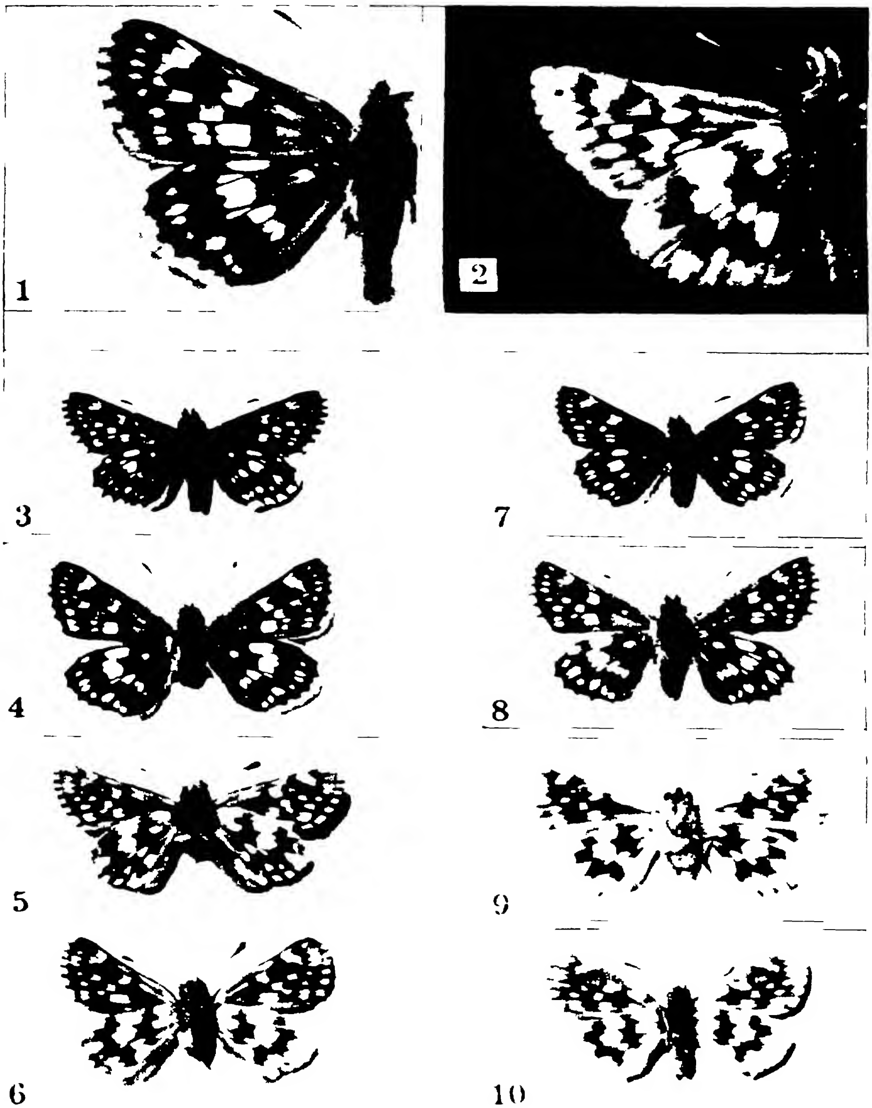
ab. **tesselloides**, nov. (Pl. LX, fig. 5.)

Specimens with the marginal row of spots underside hind-wings distinctly separated.

ab. **incompleta**, nov. (? race).

Specimens with the median row of spots upperside broken as in *tessellum*, spots 5 and 6 wanting.

This is another very *tessellum*-like form. It is rare among European specimens, especially in the ♂. In the Altai it is apparently common; there are quite a number of specimens of it, from that locality, in the British Museum collection.



[illegible] *bre* [illegible]

1 Upperside [illegible] Underside 2

Natural size

3 · Kuku Nor Tibet		7	South Russia
4 ·		8	Kuku Nor Tibet
5 · ab *tessellloides* Sarepta		9	South Russia
6 · Aksu Eastern Turkestan		10	

It is even possible that it is a race in Eastern regions. This aberration, however, does not form as perfect an imitation of *tessellum* as *tesselloides* does; the other white markings of the upperside remaining typical, and consequently the specimens still appear much more heavily marked than *tessellum.*

There is little else worth recording in variation; the nervures on the underside of the hind-wings, which are usually finely and very clearly marked in white, are occasionally somewhat suffused by the ground-colour, but, even in such examples, some part of the nervures can still be seen distinctly marked.

Date of Emergence and Duration of Flight Period.—Our knowledge of the habits of *cribrellum* is as fragmentary, or even less, than that concerning *tessellum.* Specimens bearing the date of capture are almost non-existent. It is supposed to occur in May, but whether early or late, or if it extends into June, we do not know. The only accurate data I have been able to find are supplied by three specimens in the Sheldon collection, which were taken at Sarepta on the 29th and 30th of May, 1914. As no further specimens were taken in June, it looks as if the three were the last of their kind for that season, and that probably the time of greatest abundance of the species would have been at least a fortnight earlier.

Distribution.—*Cribrellum* seems confined in Europe to south-eastern Russia, but it is widely distributed in Western Asia, and extends eastwards into China.

European localities :—

Russia.—South Russia (Bethune-Baker coll.); Sarepta (Sheldon, British Museum coll., Bethune-Baker coll., etc.).

XI. Supplementary Notes.

Note (1) (*p.* 79) – In addition to the two aberrations of *H. malvae* mentioned, one must add the following, which also have not been known to occur in *malvoides* : ab. *bilineata*, Rev., ab. *scabellata*, Rev., and ab. *pseudotaras*, Lacr.

Note (2) (*p.* 93).—I have recently been shown a specimen of *H. onopordi* taken on the Simplon Pass between the Ganter Bridge and the 10th kilometre stone, on September 2, 1926, by T. Bainbrigge Fletcher. This specimen was therefore taken at an altitude of 4600 ft. It was, however, the only specimen of *onopordi* among several other Hesperids which were obtained at the same place and time, so it is possible that it had strayed up the valley of the Ganter from lower down, where the species is known to occur. On the other hand, in view of Dr. Chapman's Allos record, there seems no reason why *onopordi* should not be established in Switzerland at this altitude, which is still 700 ft. below the Zermatt level.

Note (3) (*p.* 128).—In corroboration of the suggestion that the 1st brood can on occasions extend into July, it is interesting to note that on July 9, 1926, I captured one very worn ♀ *armoricanus* at Corte, Corsica (about 1400 ft. altitude). The season was a backward one in Corsica, and no other specimens were seen. Nine days later (July 18) the Rev. G. Wheeler took another worn ♀ on the Col de Vizzavona, and saw what was almost certainly a second. This was at an altitude of 3850 ft. A week later I searched this locality again, but found no further specimens. Considering the backwardness of the season, there is

little doubt that in both cases these were 1st brood specimens, it being impossible that in such circumstances the 2nd brood could have been *over* at these dates. Further, at Tattone, which is but a few miles from the Col de Vizzavona and more than 1200 ft. lower, the 2nd brood had not emerged by August 10. In 1911 Mr. A. E. Gibbs took some worn specimens at Tattone on June 30; and in 1925 Mr. H. Powell found some on the Col de Vizzavona in late June. Climatic conditions in the latter locality (which is by far the highest altitude at which *armoricanus* has as yet been found) render it impossible that these June specimens could have been other than the 1st brood; and the same may be said of Tattone.

Note (4) (*p.* 129).—In view of the Corsican July records, it is equally possible that they were 1st brood.

Note (5) (*p.* 151).—ab. **fulvosatura**, Vty. This name was given to a figure of Oberthür's (*Lép. Comp.* vi, fig. 1266), of a ♂ from Algeria, which differed from the type in having the markings of the upperside more or less obscured by fulvous superscaling. Verity, on the strength of this one specimen (which had been taken in August), states that *fulvosatura* is the form of the second brood; an unjustifiable assumption, and as it turns out a very misleading one, as the species is single-brooded.

XII. Synonymic List of the Palaearctic Hesperiinae.

HESPERIINAE.

NISONIADIDI.

Nisoniades, *Hübner* (Thanaos, *Bdv.*; Hallia, *Tutt*).

tages, *Linn.* (Genotype) (subclarus, *Vty.*).
s.-sp. cervantes, *Grasl.*
race sinina, *Grum.-Grsh.*
race popoviana, *Nordm.*
race clarus, *Carad.*
race isabellae, *Lamb.*
race unicolor, *Frr.*
ab. alciodes, *Tutt.*
ab. transversa, *Tutt.*
ab. variegata, *Tutt.*
ab. approximata, *Lowe.*
montanus, *Brem.* (rusticanus, *Btlr.*) (*Mabille*).
leechi, *Elw.* & *Edw.* (*var.* nigrescens, *Leech*) (*Mabille*).
marloyi, *Bdv.* (sericea, *Frr.*; rustan, *Koll.*) (*Mabille*).
pelias, Leech.
race erebus, *Grum.-Grsh.*

ERYNNIDI.

Erynnis, *Schrank* (Urbanus, *Hb.*).

alceae, *Esp.* (Genotype) (malvae, *Hb.*, gemina, *Led.*).
s.-sp. australis, *Zell.* (praeaustralis, *Vty.*; magnaustralis, *Vty.*; griseofulva, *Vty.*).
race tripolina, *Vty.*
ab. fulvocarens, *Vty.*

Spilothyrus, *Duponchel.*

althaeae, *Hb.* (Genotype) (malvarum *var.*, *Ochs.*; floccifera, *Zell.*).
s.-sp. australiformis, *Vty.* (fulvipinnulis, *Vty.*).
baeticus, *Rbr.* (marrubii, *Rbr.*; fulvescens, *Vty.*; fulva, *Vty.*).
s.-sp. octodurensis, *Obth.*
race oberthuri, *Vty.*
ab. rostagnoi, *Vty.*
ab. grisea, *Vty.*
ab. viridescens, *Vty.*
stauderi, *Rev.* (ambigua, *Vty.*).
race fulvissima, *Vty.*
ab. obscurata, *Vty.*
orientalis, *Rev.*
ramses, *Rev.*

Carcharodus, *Hübner.*

lavatherae, *Esp.* (Genotype) (alceae, *Fabr.*).
s.-sp. rufescens *Obth.* (australissima, *Vty.*).
s.-sp. australior, *Vty.*
tauricus, *Rev.*

HESPERIIDI.

Hesperia, *Fabricius* (Thymele, *Fab.*; Pyrgus, *Hb.*; Syrichtus, *Bdv.*; Bremeria, *Tutt*).

s.-gn. Teleomorpha, *Warren.*
centaureae, *Rbr.*
ab. fasciata, *Warr.*
ab. striata, *Warr.*
freija, *Warr.*
ab. fasciata, *Warr.*
sibirica, *Rev.*
chapmani, *Warr.*
andromedae, *Wallgr.*
ab. reducta, *Warr.*
ab. perseus, *Schawerda.*
cacaliae, *Rbr.*
ab. caeca. *Rev.* (restricta, *Hoffm.*).
ab. reducta, *Warr.*
sidae, *Esp.*
s.-sp. occidentalis, *Vty.* (occidua, *Vty.*).
ab. hafneri, *Stauder.*
ab. reducta, *Warr.*
alpina, *Ersch.*
race (? *s.-sp.*) darwazica, *Grum.-Grsh.*
maculata, *Brem.* (amurensis, *Stgr.*) (*Mabille*).
zona, *Mab.* (sinicus, *Butl.*) (*Mabille*).
race bocki, *Obth.*
albistriga, *Mab.*
thibetana, *Obth.*
carthami, *Hb.* (malvae, *Esp.* (nec *Linn.*); tessellum, *Ochs.* (nec *Hb.*)).
s.-sp. valesiaca, *Mab.* (valesina, *Mab.*; speciosa, *Vty.*).
s.-sp. nevadensis, *Obth.*
s.-sp. moeschleri, *Herr-Sch.*
race pyrenaica, *Warr.*
ab. reducta, *Warr.*
ab. vittatus, *Obth.*
ab. duosignata, *Kilian.*
ab. immaculata, *Warr.*
ab. sidaeformis, *Warr.*
ab. galactites, *Ramb.*
cashmirensis, *Moore.*
bieti, *Obth.*
race yunnana, *Obth.*
oberthüri, *Leech.* (delavayi, *Obth.*).

s.-gn. Hemiteleomorpha, *Warren.*
malvae, *Linn.* (Genotype of Hesperia) (morio, *Scop.*; fritillarius, *Poda*; cardui, *Latr.*; sao, *Bergs.*; malvae minor, *Esp.*; lavaterae, *Fab.* (nec *Esp.*); alveolus, *Hb.*; alveolus, *Rbr.* (nec *Hb.*) [Faun. And., pl. 8, figs. 15 & *r*]).

race (? *s.-sp.*) graeca, *Obth.*
ab. taras, *Bergstr.* (althaeae, *Esp.*; fritillum, *Fab.*; fritillum, *Lewin* (nec *Hb.*); alveolus, *Hb.*; lavaterae, *Haworth* (nec *Esp.*)).
ab. intermedia, *Schilde.*
ab. pseudotaras, *Lacr.*
ab. scabellata, *Rev.*
ab. bilineata, *Rev.*
ab. marginoelongata, *Rev.*
ab. fasciata, *Tutt.*
ab. restricta, *Tutt.*
ab. albina, *Tutt.*
ab. zagrabiensis, *Grund.*
ab. reducta, *Warr.*
malvoides, *Elw.* & *Edw.* (fritillum, *Hb.*; fritillum, *Rbr.* [Faun. And., pl. 8, figs. 14 & *q*]; pseudomalvae, *Vty.*; luctuata, *Vty.*; alpina, *Tutt;* andalusica, *Tutt;* australis, *Tutt.*).
ab. taras, *Warr.*
ab. intermedia, *Warr.*
ab. fasciata, *Warr.*
ab. restricta, *Warr.*
ab. albina, *Warr.*
ab. semiconfluens, *Rev.*
ab. reducta, *Warr.*
ab. pyrenaica, *Tutt* (fritillans, *Obth.*).
ab. tutti, *Vty.* (melotis, *Tutt* nec *Dup.*).
pontica, *Rev.*
melotis, *Dup.* (hypoleucos, *Led.*).
ab. reducta, *Warr.*
s.-gn. ATELEOMORPHA, *Warren.*
onopordi, *Rbr.* (funginus, *Schilde*; subconyzae, *Vty.*; venusta, *Vty.*).
race (and *form*) fulvotincta, *Vty.* (tersissima, *Vty.*; rubescens, *Vty.*; tersior, *Vty.*; pallidissimefulva, *Vty.*; postgenita, *Vty.*).
race quercii, *Obth.*
ab. pallidissima, *Vty.*
ab. albovelata, *Vty.*
ab. reducta, *Warr.*
ab. conyzae, *Guenée.*
ab. nigrosatura, *Vty.*
serratulae, *Rbr.* (latealbata, *Vty.*).
s.-sp. occidentalis, *Lucas.*
s.-sp. balcanica, *Warr.*
s.-sp. uralensis, *Warr.*
race major, *Stgr.*
race alveoides, *Stgr.*
race planorum, *Vty.*
ab. tarasoides, *Höfn.*
ab. caecus, *Frr.* (nigra, *Hoffm.*; restricta, *Hoffm.*).
ab. conspersa, *Rev.*
ab. ochracea, *Rev.*
ab. extensa, *Warr.*
ab. alveformis, *Warr.*
ab. fragilis, *Vty.*
carlinae, *Rbr.* (olivacea, *Obth.*; atrata, *Vty.*).
ab. extensa, *Warr.*
ab. fasciata, *Warr.*
fritillum, *Schiffermüller* (cirsii, *Rbr.*; nigrocarens, *Vty.*).
s.-sp. (et *ab.*) iberica, *Grum.-Grsh.* (fabressei, *Obth.*; parafabressei, *Vty.*).
race (? *s.-sp.*) siciliae, *Obth.*
race herrichii, *Obth.*
ab. extensa, *Warr.*
alveus, *Hb.*
s.-sp. sifanicus, *Grum.-Grsh.*
s.-sp. iliensis, *Rev.* (? a species).
s.-sp. accreta, *Vty.*
s.-sp. centralhispaniae, *Vty.*
s.-sp. centralitaliae, *Vty.*
race ryffelensis, *Obth.*
race (? *s.-sp.*) trebevicensis, *Warr.* (reverdini, *Schaw.*).
race jurassica, *Warr.*
ab. extensa, *Warr.*
ab. serratulaeformis, *Warr.*
ab. lineolata, *Rev.*
ab. scandinavicus, *Strand.* (alticola, *Rebel*; ballotae, *Obth.*; albens, *Vty.*; suffusa, *Strand.*; serratuloides, *Heinrich*).
numida, *Obth.*
armoricanus, *Obth.* (jaceae, *Guenée* in litt.).
race persica, *Rev.*
race fulvoinspersa, *Vty.* (tersa, *Vty.*; rufosatura, *Vty.*).
race reverdini, *Le Cerf.*
ab. onopordiformis, *Vty.*
ab. enervata, *Vty.*
ab. extensa, *Warr.*
foulquieri, *Obth.* (alveus *race* grandis, *Vty.*).
s.-sp. (et *race*) bellieri, *Obth.*
race picena, *Vty.*
ab. supra-bellieri, *Vty.*
ab. extensa, *Warr.*
speyeri, *Stgr.*
race seitzi, *Mab.*
reverdini, *Obth.*
schansiensis, *Rev.*
cinarae, *Rbr.*
RAMBURIA, *Warren.*
antonia, *Spr.* (Genotype).
race (? *s.-sp.*) gigantea, *Stgr.*
POWELLIA, *Tutt.*
geron, *Wats.*
struvei, *Pungeler.*
adenensis, *Btlr.*
race amenophis, *Rev.*
sertorius, *Hoffmsgg.* (sao, *Hb.*) (Genotype).
race gavarniensis, *Warr.*
race guadarramensis, *Warr.*
race eucrate, *Esp.*
race gracilis, *Vty.* (subgracilis, *Vty.*).
ab. tesselloides, *H.-S.*
ab. parvula, *Vty.*

ab. subtus-brunnea, *Rev.*
ab. kempnyi, *Schawerda.*
therapne, *Rbr.*
ali, *Obth.*
form therapnoides, *Obth.*
orbifer, *Hb.* (orbifera, *Latr.*).
form secunda, *Graves.*
race (? *s.-sp.*) hilaris, *Stgr.*
race lugens, *Stgr.*
phlomidis, *Herr.-Sch.*
galba, *Fab.* (superna, *Moore*; evanidus, *Btlr.*; zebra, *Btlr.*; hellas, *Nicév.*) [*Mabille*].
SLOPERIA, *Tutt* (Muschampia, *Tutt*).
poggei, Led. (Genotype).
ioan, *Warr.*
lutulentus, *Grum.-Grsh.*
plurimacula, *Chr.*
proto, *Esp.*
race gigas, *Vty.*
race aragonensis, *Sagarra.* (rubea, *Sag.*; fenestrata, *Sagarra*).
race nigrita, *Vty.*
ab. fulvosatura, *Vty.*
mohammed, *Obth.*
ahmed, *Obth.*
REVERDINIA, *Warren.*
staudingeri, *Spr.* (Genotype).
race (? *s.-sp.*) epimetheus, *Mab.*
albata, *Rev.*
proteus, *Stgr.*
race prometheus, *Grum.-Grsh.*
TUTTIA, *Warren.*
tessellum, *Hb.* (Genotype). (hibisci, *Böber*). [*Plötz.*]
s.-sp. nomas, *Led.*
ab. cribrelloides, *Warr.*
ab. nigricans, *Mab.*
leuzeae, *Obth.*
gigas, *Brem.* (? *s.-sp.* of tessellum).
race dilutior, *Rühl.*
ab. minor, *Mab.*
protheon, *Rbr.* (? *s.-sp.* of tessellum).
nobilis, *Stgr.*
race kuenlunus, *Grum.-Grsh.*
race (? *s.-sp.*) fucata, *Mab.*
FAVRIA, *Tutt.*
cribrellum, *Evers.* (Genotype).
race hybrida, *Mab.*
ab. obscurior, *Stgr.*
ab. tesselloides, *Warr.*
ab. (? *race*) incompleta, *Warr.*

Note.—Through the kindness of Mr. O. R. Goodman I have, at the moment of going to press, received specimens and dissections of *S. ahmed* and *T. leuzeae*, of which until now the anatomy has remained unknown. These have enabled me to place them in the genera to which they belong, but a discussion of their specific affinities must unfortunately be held over for publication later.

XIII. Index to Monograph, with References to the Original Descriptions.

N.B.—Names in Italics refer to non-European species; those in small type are synonyms.

NEW SPECIES OF STAPHYLINIDAE FROM INDIA

By Malcolm Cameron, M.B., R.N.

Part III (continued from Vol. [73] 1925, p. 372).

[Read November 18th, 1925.]

Trichophyinae.

Trichophya rudis, n. sp.

Shining black, the thorax obliquely impressed at the posterior angles, elytra pitchy-black. Antennae and legs brownish-testaceous. Length 2·5 mm.

Differs from *T. pilicornis*, Gyll. (which I have found in the Simla Hills), in the longer, less transverse thorax and coarser puncturation of the fore-parts. Head closely punctured. Antennae with the first two joints dilated, the following very slender and elongate. Thorax transverse (5·5 : 3·5), widest about the middle, the sides uniformly rounded, the posterior angles obtuse and distinctly obliquely impressed, closely, moderately finely punctured. Elytra longer (5 : 3·5) and broader than the thorax, a little longer than broad, as closely but more roughly punctured than the thorax. Abdomen finely, closely punctured and finely pubescent.

Simla Hills; Gahan. Chakrata District; Binal Gad, Kanasar, Dodora Khud, 7000 to 8000 feet above the sea.

Trichophya obsoleta, n. sp.

Shining black, thorax not impressed at the posterior angles. Antennae testaceous, the first two joints scarcely infuscate. Legs testaceous. Length 2 mm.

Very similar in build to the preceding, but smaller and less robust, the thorax not impressed at the posterior angles and the puncturation of the fore-parts much less coarse.

Chakrata District; Binal Gad, 7000 to 8000 feet above the sea.

Termitodiscinae.

Termitodiscus minutus, n. sp.

Minute, subdepressed, shining yellowish-brown the lateral and anterior margins of the thorax yellow; thorax, elytra and abdomen clothed with short, stiff, yellow backwardly directed hairs. Length ·7 mm. Breadth ·5 mm.

The smallest species of the genus. From the description and figures would appear to be very similar in build to *T. escherichi*, Wasm., but to differ in colour, longer antennal club with shorter terminal joint which is much shorter than the rest of the club; from *T. butteli*, Wasm., by the colour, different build and rather longer antennal club with shorter terminal joint. Head completely concealed beneath the thorax, impunctate, shining. Antennae with the 1st joint moderate in length, the following forming a club gradually increasing in width from the base to the middle of the last joint, about three times as long as broad, the 10th joint semi-oval. Thorax nearly semicircular, transverse (5 : 3), overlapping the base of the elytra, the posterior angles acute, finely but not closely punctured, each puncture with a short stiff yellow hair which is directed backwards. Elytra much shorter than the thorax (1 : 3 along the suture), strongly transverse, with asperate punctures which are a good deal closer than those of the thorax and furnished with

a similar hair. Abdomen narrower than the elytra, strongly contracted from the base to apex, the sculpture much less distinct but about as close as that of the elytra and with similar stiff hairs, the sides moderately reflexed without long setae.

Dehra Dun. In the nest of a Termite.

PYGOSTENINAE.

Doryloxenus brevicornis, n. sp.

Convex, fusiform, shining. Head pitchy, in front more or less broadly reddish, thorax reddish, elytra pitchy, abdomen reddish. Antennae and legs brownish red. Length 2·2 mm. Breadth ·75 mm.

Differs from *D. transfuga*, Wasm., by the shorter antennae. From *D. termitophilus*, Wasm., by the larger size, convex head, etc. Head slightly convex, eyes visible from above, the side margins in front of them obliquely truncate to the rounded anterior border, no perceptible sculpture, glabrous. Antennae very thick, conical, horn-like, about as long as the head. Thorax transverse (7 : 4·5), the sides gently rounded, the anterior and posterior angles rounded, the former a little produced, without sculpture or pubescence. Elytra along the suture shorter than the thorax (3 : 4·5) and a little broader, the sides feebly rounded, glabrous and impunctate. Abdomen strongly pointed from base to apex, the sides strongly margined; these and the apex with long black setae, otherwise glabrous and impunctate.

Siwaliks; Lachiwala. With a species of Termite.

Doryloxenus wasmanni, n. sp.

Very shining, fusiform, convex, impunctate and without pubescence, reddish yellow-brown. Antennae reddish-brown, thick, pointed, scarcely longer than the head. Length 1·4 mm. Breadth ·5 mm.

A slender species. Distinguished from *D. butteli*, Wasm., by the more shining surface and shorter elytra. Head broadly impressed in front, eyes not visible from above. Thorax transverse (4·5 : 3), the sides gently rounded. Elytra along the suture shorter (2 : 3) than the thorax, transverse, the sides rounded, the posterior margins broadly emarginate. Abdomen strongly narrowed from base to apex, as long as the fore-parts, at the sides with some yellow setae, the apex with black setae.

Dehra Dun. In the nest of a Termite.

Doryloxenus longesetosus, n. sp.

Very shining, fusiform, subdepressed, yellowish-red. Antennae very short and thick, reddish-brown, the apex testaceous. Length 1·2 mm. Breadth ·4 mm.

Near *D. eutermitis*, Wasm., but more shining, the antennae much shorter, the abdominal setae much longer. Head broadly impressed on the vertex, the sides and anterior border rounded in a semicircle, the eyes not visible from above, with a few extremely fine and sparing punctures, glabrous. Antennae very short and thick, pointed, shorter than the head. Thorax transverse (3·5 : 2·3), widest behind, the sides feebly rounded, anterior margin broadly, feebly emarginate, the anterior angles rounded and a little produced, similarly punctured to the head, glabrous. Elytra along the suture much shorter than the thorax (1·3 : 2·3), but a little broader, transverse, the posterior margin deeply emarginate, the postero-external angles produced, the sides rounded, with a few very fine punctures, glabrous. Abdomen strongly narrowed from base to apex, each of the first four (visible) segments with a transverse row of long yellow setae, the last two with more numerous ones, the sides without setae, the apex with numerous black ones.

Dehra Dun. In the nest of a Termite.

TACHYPORINAE.

Mycetoporus (Ischnosoma) indicus, n. sp.

Black, shining; the shoulders and posterior margin of the elytra broadly rufo-testaceous. Abdomen with the posterior margins of the segments more or less rufescent. Antennae black, the first two joints testaceous. Legs testaceous. Length 3·5 mm.

Size and build of *M. niger*, Fairm., but with longer antennae; in colour nearer *M. reichei*, Pand. Head with a very few scarcely perceptible punctures and without ground-sculpture. Antennae rather long, thickened distally, 3rd joint shorter than 2nd, 4th to 8th all distinctly longer than broad, 9th and 10th as long as broad, 11th longer than 10th. Thorax with the marginal punctures fine, the median anterior pair situated some distance from the margin, the external nearer thereto, and with a few other scarcely perceptible ones and without ground-sculpture. Elytra a little longer than broad, with a row of nine or ten sutural punctures, eight or nine humeral and ten or eleven along the reflexed margin; ground-sculpture wanting. Abdomen finely, not very closely, punctured and without ground-sculpture; pubescence yellow, scanty and with numerous long, black semi-erect setae.

Dehra Dun.

Mycetoporus (Ischnosoma) himalayicus, n. sp.

Black, shining; the anterior and posterior margins of the thorax narrowly testaceous; elytra with an oblong, longitudinal spot at the shoulders, the posterior external angles and posterior margin narrowly testaceous. Abdomen with the posterior margins of the segments narrowly rufescent. Antennae dark, the first two joints testaceous. Legs testaceous, the posterior femora and tibiae brownish. Length 4·5 mm.

General facies of the preceding but the antennae shorter, the humeral spot less diffuse, the posterior margins of the elytra more narrowly testaceous, the sculpture of the abdomen coarser and without long black setae. Head without sculpture. Antennae with 3rd joint about as long as 2nd, 4th to 6th a little longer than broad, gradually decreasing in length but increasing in thickness, 7th and 8th as long as broad, 9th and 10th slightly transverse. Thorax with the median pair of punctures some distance from the anterior border, the lateral a little less distant; ground-sculpture wanting. Elytra longer than broad, with a sutural row of eight or nine, a humeral and lateral each of ten punctures; just external to the humeral series a row of five or six very fine punctures is discernible; ground-sculpture extremely fine, transversely strigose. Abdomen moderately finely and moderately closely punctured, with rather coarse sparse yellow pubescence and without ground-sculpture.

Chakrata District; Binal Gad, 7000 to 8000 feet above the sea.

Mycetoporus (s. str.) **perniger,** n. sp.

Narrow, elongate, black, shining. Elytra with three series of punctures. Antennae brown, the first two and the last joint testaceous. Legs reddish-brown. Length 5 mm.

Narrower than the preceding species, with shorter antennae, entirely black, the postero-external angles of the elytra scarcely perceptibly lighter. Head without puncturation or ground-sculpture. Antennae short, the 2nd and 3rd joints subequal, 4th about as long as broad, 5th to 10th transverse, gradually increasing in breadth, the penultimate twice as broad as long. Thorax with the median and

lateral punctures equidistant and remote from the anterior border. Elytra as long as broad, with a sutural and humeral series each of five or six fine punctures and a lateral of eight; no visible ground-sculpture. Abdomen with moderately fine, elongate punctures and a fine, yellowish, sparse pubescence and without ground-sculpture.

Simla Hills; Matiana, 7900 feet above the sea.

Bolitobius humeralis, n. sp.

Black, shining; elytra with a large subcordate humeral spot and the posterior margin, sutural and postero-external angles distinctly testaceous. Abdomen with the posterior margins of the anterior segments narrowly and obscurely paler, the 6th rather broadly testaceous. Antennae with the first two and base of the 3rd joint and apex of the last, testaceous. Anterior legs reddish-testaceous, the middle and posterior femora and tibiae brown, the latter reddish-testaceous at the bases. Length 5·75 mm.

Very similar in appearance to *B. distinctus*, Schub., but differs in the broader, oval head and the shape of the elytral spot; build of *B. trinotatus*, Er., but with head dilated behind the eyes. Head oval, narrowed in front, the post-ocular space rounded and slightly dilated. Antennae with the 3rd joint longer than 2nd, 4th slender, a little longer than broad, 5th to 10th about as long as broad and differing little amongst themselves, 11th stout, oval, a little longer than 10th. Thorax impunctate (except for the usual marginal punctures) and without ground-sculpture, the base finely bordered. Elytra wider and a little longer than the thorax, a little longer than broad; at the shoulder with a large subcordate yellow spot, placed obliquely with the apex at the antero-external angle and not reaching the suture, the outer margin of the spot extends almost half the length of the elytron, the inner not so far; the narrow testaceous apical marking extends a short way along the suture and is dilated near the postero-external angle; each with three rows of punctures, sutural four or five, discal four or five, marginal seven or eight. Abdomen pointed, very finely and very sparingly punctured on 3rd to 5th segments, more closely on 6th, the pubescence scanty, yellow.

Simla Hills; Gahan, 7000 feet above the sea.

Bolitobius simlaensis, n. sp.

Shining. Head black, thorax brown, the lateral margins and base testaceous. Elytra pitchy-black, a large hastate humeral spot and the posterior margin testaceous. Abdomen brownish-testaceous, the whole of the 1st, and the posterior margins of the following segments testaceous. Antennae blackish, the first four joints and apex of the last testaceous. Legs testaceous. Length 4·3 mm.

Build of *B. pygmaeus*, F. Head short, not much longer than broad, the temples parallel. Antennae with 2nd and 3rd joints of equal length, 4th and 5th slightly longer than broad, 6th and 7th about as long as broad, 8th to 10th slightly transverse, 11th a little longer than 10th. Thorax not bordered at the base. Elytra longer than broad, pitchy, with a large yellow humeral spot which extends nearly half the length of the external margin and internally is prolonged towards the middle of the suture forming a mark somewhat similar to the point of a spear, the posterior margin is narrowly testaceous, a little more broadly at the sutural and external angles; each with a row of nine fine sutural, seven or eight discal and nine or ten marginal punctures. Abdomen with the 1st (visible) segment nearly impunctate, the following moderately finely, sparingly punctured, the 5th more closely, pubescence scanty, stiff, yellow, mixed with sparse black setae.

Simla Hills; Gahan, 7000 feet above the sea.

Bolitobius proximus, n. sp.

Black, shining; base of thorax not bordered. Elytra with large testaceous oval humeral spot, the posterior margin extremely narrowly and obscurely testaceous. Abdomen pointed, the posterior margins of the first four (visible) segments very narrowly rufescent. Antennae fusco-testaceous, the first four joints testaceous, the penultimate transverse. Legs testaceous, the intermediate and posterior tibiae more or less infuscate. Length 4·75 mm.

Build of *B. exoletus*, Er., but narrower. Very near *B. humeralis*, m., but differing in the more slender build, smaller size, narrower, oblong head, shorter, lighter antennae with the 6th to 10th joints distinctly transverse, the oval, noncordate humeral spot which however is similarly situated, the extremely narrow and obscurely lighter posterior border of the elytra, the posterior angles not widely testaceous and the entirely black 6th abdominal segment. From *B. distinctus*, Schub., by the broader and much shorter head, lighter antennae with transverse penultimate joints, differently shaped humeral spot and entirely black 6th abdominal segment.

Simla Hills; Gahan, 7000 feet above the sea.

Bolitobius monticola, n. sp.

Black, shining; elytra at the shoulders with oval yellow spot, the posterior margin scarcely perceptibly lighter. Abdomen with the posterior margins of the first four (visible) segments narrowly rufescent. Antennae blackish, the first five joints testaceous, the penultimate transverse. Legs reddish-testaceous, the tibiae a little infuscate. Length 3·3 mm.

A small narrow species, much narrow than *B. exoletus*, Er., with a short oval head and markings of *B. proximus*, m. Antennae with 3rd joint shorter than 2nd, 4th a little longer than broad, 5th to 10th transverse. Thorax entirely black, the base not bordered. Elytra longer than the thorax, longer than broad, at the shoulders with a somewhat oval yellow spot; not reaching the suture and extending backwards for about one-third the length of the elytra, sculpture consisting of three rows of six punctures, sutural, discal and lateral. Abdomen finely, sparingly punctured, especially in the middle of the anterior segments and with rather scanty, long yellow hairs and a few black setae.

Simla Hills: Theog, Kotgarh, 7000 to 7600 feet above the sea.

TABLE OF THE ABOVE-DESCRIBED SPECIES OF *BOLITOBIUS*.

1. Species in great part brownish-testaceous . . . . . *simlaensis*, n. sp.
— Species black with yellow markings . . . . 2.
2. Base of thorax finely bordered. Penultimate joints of antennae not transverse. Size larger 5·75 mm. . . . . *humeralis*, n. sp.
— Base of thorax not bordered. Penultimate joints of antennae transverse. Smaller species 3·3 to 4·7 mm. . . . . 3.
3. Larger and broader (4·75 mm.). Antennae longer and thicker *proximus*, n. sp.
— Smaller and narrower (3·3 mm.). Antennae shorter and more slender *monticola*, n. sp.

Bryocharis bicolor, n. sp.

Shining black; the elytra shining red, the epipleurae and postero-external angles black, with three rows of extremely fine punctures and traces of others. Antennae with the 1st joint and apex of the last testaceous. Legs brownish-red. Length 6·75 mm.

Broader and more robust than *B. analis*, Payk., with shorter antennae and different coloration. Head impunctate and without ground-sculpture. Antennae with the 3rd joint much longer than 2nd, 4th to 7th a little longer than broad gradually decreasing in length, 8th as long as broad, 9th and 10th transverse, 11th not so long as the two preceding together. Thorax with median pair of punctures more remote from the anterior border than are the lateral ones, these themselves separated therefrom. Elytra a little longer than broad, with rows of exceedingly fine punctures: nine or ten sutural, four humeral (more widely separated and situated anteriorly), eight or nine discal (between which and the humeral there are five others, and along the margin eight or nine more), occasionally with traces of five others between the discal and sutural rows. Abdomen with the first two (visible) segments with a few fine punctures towards the sides, the disc glabrous, the 3rd and 4th with some very fine punctures across the base, the middle and the posterior margins, 5th with moderately close, fine, elongate punctures, 6th finely, sparingly punctured; pubescence fine and sparse, with long black setae at the posterior margins and sides.

Dehra Dun. Chakrata District; Sijla Gad, 5000 feet above the sea.

Bryocharis humeralis, n. sp.

Black, shining; the elytra with large humeral spot and posterior margin narrowly yellow and with seven rows of fine punctures. Antennae black, the 1st and 11th joints testaceous. Legs testaceous, the apices of the tibiae and the intermediate and posterior tarsi more or less blackish. Length 8 mm.

Scarcely differs in build from *B. analis*, Payk. Head impunctate and without ground-sculpture. Antennae with 3rd joint considerably longer than 2nd, 4th and 5th a little longer than broad, 6th and 7th as long as broad, 8th to 10th slightly transverse, 11th short, oval, not as long as the two preceding together. Thorax with median punctures further from the anterior margin than are the lateral and with a few scarcely perceptible punctures on disc, without ground-sculpture. Elytra a little longer than broad with seven rows of ten or twelve fine punctures. Abdomen with the 1st (visible) segment with a few fine punctures at the sides and along the posterior margin, 2nd with three rows, basal, medial and apical, all interrupted in the middle so that this region is impunctate, 3rd and 4th with the rows not interrupted, 5th and 6th finely, uniformly and moderately closely punctured, pubescence short fine and sparse and with long black setae.

Simla Hills; Theog, 7600 feet above the sea.

Conosoma subtestaceum, n. sp.

Identical in build, size, colour and antennal structure with *C. testaceum*, F., but differs in the following respects, the puncturation of the elytra is less close, that of the abdomen is distinctly less fine and less close and the pubescence less dense and much coarser especially on the abdomen. In the ♂ the 5th ventral segment is not emarginate.

Chakrata District; Chulli Khud, Korawa Khud, Khedar Khud, Jadi Gad, 7000 to 9000 feet above the sea.

Conosoma plagiatum, Fauv., v. **unicolor**, n.

Differs only from the type form in the complete absence of the orange elytral marking, the whole insect being entirely sooty-black.

Simla Hills; Matiana, 7900 feet above the sea.

Conosoma subgracile, n. sp.

Narrow, elongate, black, sericeous; elytra with well-defined curved orange fascia (C-shaped), extending from the humeral angle to the posterior margin, this and the posterior angles similarly coloured. Antennae with the first three or four joints testaceous, the rest blackish. Legs testaceous. Length 4 mm. (in well-extended examples).

Very near *C. gracile*, Kr., in build, markings, etc., but the antennae are shorter and darker. Head very finely and sparingly punctured and pubescent. Antennae slender, extending very slightly beyond the posterior angles of the thorax, all the joints longer than broad, gradually decreasing in length, the 10th not much longer than broad. Thorax slightly transverse, extremely finely and closely shagreened and punctured, finely and closely pubescent. Elytra one-third longer than the thorax, exceedingly finely and exceedingly closely punctured, very finely and closely pubescent, sericeous. Abdomen slender, narrowed from base to apex, extremely finely and closely punctured and pubescent, the sides and apex with black setae.

Chakrata District; Korawa Khud, Sijla Gad, 5000 to 9000 feet above the sea. Simla Hills; Kotgarh, 7000 feet above the sea.

Conosoma vittatum, n. sp.

Narrow, elongate, black, subsericeous; the elytra with a curved orange fascia extending from the humeral callus to near the posterior margin internally and gradually tapering behind, posterior margin and postero-external angles black. Antennae black with the first three joints and the last testaceous. Legs testaceous. Length 4 mm. (in extended examples).

Size and build of the preceding, but differs in the testaceous 11th antennal joint, the elytral marking and the less densely pubescent thorax, which has not a silky appearance. The elytral spot is comma-shaped with the concavity outwards and the end of the tail near the sutural end of the posterior margin.

Simla Hills; Theog, 7000 feet above the sea.

Conosoma triste, n. sp.

Narrow, elongate, black; the head and thorax moderately shining, elytra and abdomen more opaque, sericeous. Antennae and legs testaceous. Length 3·2 mm. (in moderately extended examples).

Intermediate in build between *C. plagiatum*, Fauv., and *C. gracile*, Kr., a good deal smaller and narrower than the former, more robust than the latter. Head very finely and closely punctured, finely pubescent. Antennae long and slender extending well beyond the posterior angles of the thorax, all the joints much longer than broad, the 11th longer than the 10th. Thorax slightly transverse, extremely finely and closely punctured, finely pubescent. Elytra a good deal longer than the thorax, longer than broad, more finely and densely punctured than the thorax, sericeous. Abdomen densely and finely punctured and grey pubescent, sericeous.

Mussorie District; Keyarkuli, 5000 feet above the sea.

Conosoma obscurevittatum, n. sp.

Head black, shining, thorax and elytra pitchy-black, the posterior margin of the former very narrowly and obscurely rufescent, the latter with an obscure curved

reddish fascia extending from the shoulder to the posterior margin near the suture, the posterior margin and postero-external angle similarly rufescent, thus forming an ill-defined C-shaped marking, more visible in certain lights. Abdomen pitchy, the posterior margins of the anterior segments narrowly rufescent. Antennae and legs testaceous. Length 4 mm. (in well-extended examples).

Size, build and antennal structure of *C. subgracile*, Cam., but more shining, less pubescent and sericeous, the elytral fascia obscure red and ill defined, the abdomen rather less finely pubescent. Head and antennae as in *C. subgracile*, Cam. Thorax slightly transverse, closely and very finely punctured and grey pubescent. Elytra longer than the thorax, distinctly longer than broad, more distinctly punctured than the thorax, finely closely grey pubescent, subsericeous. Abdomen densely and finely punctured and grey pubescent, subsericeous.

Dehra Dun.

Conosoma marginatum, n. sp.

Narrow, elongate, black, the posterior borders of the thorax and of the abdominal segments very narrowly and obscurely rufescent. Elytra with an obscure, subtriangular orange spot occupying the posterior margin. Antennae and legs testaceous. Length 5 mm.

Build of *C. gracile*, Kr., but with shorter antennae and differently marked elytra. Antennae slender, reaching a little beyond the posterior angles of the thorax, all the joints longer than broad, the 10th not much longer than broad. Thorax extremely finely and very closely punctured, finely and closely pubescent, scarcely transverse. Elytra a little longer than the thorax, narrowed behind, the sides straight, exceedingly finely and densely punctured and pubescent, sericeous; at the apex with an obscure orange spot, subtriangular in shape, the base occupying the posterior margin and the apex extending for about one-fourth the length of the disc. Abdomen very finely punctured and closely pubescent, subsericeous.

Mussorie District; Arni Gad, Ringal Gad, 5000 to 6000 feet above the sea.

Conosoma rufoguttatum, n. sp.

Black, head and thorax more shining; thorax with the posterior margin narrowly rufescent, elytra pitchy, less shining, at the base of each with a reddish reniform spot with the concavity backwards and not extending either to the suture or the lateral margin, more visible in certain lights, very finely and closely punctured and yellowish pubescent. Abdomen black, the posterior margins of the segments narrowly rufescent, the 5th (visible) more broadly, finely and closely punctured, not sericeous. Antennae black, the first two joints testaceous. Legs testaceous. Length 4·5 mm.

A little larger, more robust and more convex than *C. immaculatum*, Steph., with longer antennae, the elytra rather less narrowed behind, the sides more rounded and with ferruginous basal spot, the abdomen less closely pubescent and more shining. Head very finely and very sparingly punctured, sparingly pubescent. Antennae with 4th to 6th joints longer than broad, gradually decreasing in length, 7th about as long as broad, 8th to 10th slightly transverse. Thorax slightly transverse, extremely finely, moderately closely punctured and pubescent. Elytra as long as broad, rather less closely punctured than in *C. immaculatum*, with short fine greyish pubescence, not sericeous. Abdomen much less pubescent and more shining than in that species.

Simla Hills; Kotgarh, Gahan, 7000 feet above the sea.

Conosoma parkeri, n. sp.

Narrow, elongate, black, not sericeous, the sides and posterior margin of the thorax narrowly, obscurely rufescent. Elytra with ill-defined red spot in the middle of the base, not extending to the suture or the lateral margin, the posterior margin very narrowly rufescent. Abdomen with the first 4 segments narrowly rufescent posteriorly, the 5th with the posterior half rufescent, 6th entirely black. Antennae with the first three joints and the last, testaceous, the rest infuscate. Legs testaceous. Length 3·5 mm. (in well-extended examples).

Smaller and narrower than the preceding, similarly built and marked, but the antennae lighter and more slender though similarly constructed. It is perhaps a small race of *C. rufoguttatum.*

Almora; Dhaub China, 6000 feet above the sea (*R. N. Parker, I.F.S.*). Mussorie District, Arni Gad.

Conosoma variable, n. sp.

Pitchy-brown. Head more or less rufescent in front, the lateral margins and base of the thorax narrowly rufescent. Elytra with a ferruginous, ill-defined mark occupying the base internal to the callus, the vicinity of the suture, the posterior margin and postero-external angle, thus forming a C-shaped figure open outwards, the suture and rest of the disc, pitchy. Abdomen with the posterior margins of the segments distinctly rufescent. Antennae and legs testaceous. Length 3·6 mm. (in well-extended examples). Varies considerably in the distinctness and extent of the elytral marking.

In size and general facies resembling *C. immaculatum*, Steph., but with more slender antennae, the thorax much shorter and more transverse, the elytra shorter and more convex, the abdomen more finely and more closely punctured. Antennae with 2nd and 3rd joints of equal length, 4th to 9th longer than broad gradually decreasing in length, 10th as long as broad, 11th a little longer than the preceding. Thorax strongly transverse, very finely, closely punctured and pubescent. Elytra a little longer than the thorax, as long as broad, gradually narrowed behind, rather more finely and more closely punctured and pubescent than the thorax. Abdomen very finely and closely punctured and pubescent, subsericeous.

Siwaliks; Nakraunda, Mohan Rau, Dehra Dun, Song River.

Conosoma beesoni, n. sp.

Subconvex, castaneous, the head in front and the posterior margins of the abdominal segments rufescent. Antennae short, testaceous, the 5th to 9th joints more or less infuscate. Legs testaceous. Length 2·75 mm. (in well-extended examples).

Build of the preceding, but much smaller, uniformly coloured and with shorter antennae. Head scarcely perceptibly punctured. Antennae with 2nd and 3rd joints of equal length, 4th to 6th a little longer than broad, gradually decreasing in length, 7th to 10th transverse. Thorax strongly transverse, exceedingly finely, closely punctured and shagreened, with a fine short greyish pubescence. Elytra a little longer than the thorax, narrowed behind, about as long as broad, rather more closely punctured and pubescent than the thorax. Abdomen very similarly punctured and pubescent, not sericeous.

Mussorie District; Arni Gad. Chakrata District; Khedar Khud, Chulli Khud, Sijla Gad. Simla Hills; Kotgarh, 6000 to 8000 feet above the sea.

Conosoma obscurum, n. sp.

Subconvex, castaneous, finely closely pubescent; the front of the head, sides and posterior margin of the thorax narrowly, base of the elytra broadly, the apical margin narrowly ferruginous red. Abdomen yellowish-red, paler behind. Antennae short, testaceous. Legs testaceous. Length 2·75 mm. (in well-extended examples).

Narrower than the preceding, similarly built, coloration of the elytra very similar to the obscurer forms of *C. variabile*. Head very finely and very sparingly punctured. Antennae short, scarcely reaching the posterior angles of the thorax, the 2nd and 3rd joints of equal length, 4th to 6th a little longer than broad, gradually decreasing in length, 7th to 10th transverse. Thorax strongly transverse, extremely finely, closely punctured and finely pubescent. Elytra longer than thorax, as long as broad, rather more closely punctured than the thorax, with a broad ill-defined reddish patch at the base, reaching the lateral margin but not attaining the suture, the posterior margin rufescent, sometimes the elytra lighter castaneous and then the spot scarcely distinguishable. Abdomen very similarly punctured and pubescent to the elytra, not sericeous.

Siwaliks; Lachiwala.

Conosoma c-rufum, n. sp.

Head and thorax reddish-testaceous, the latter rarely infuscate on the disc; elytra pitchy black with a red C-shaped mark extending from the humeral callus along the suture, the posterior margin and the postero-external angle, suture black, rarely with the extreme lateral margin rufescent. Abdomen pitchy black, the posterior margins of the segments broadly rufescent. Antennae testaceous, occasionally a little infuscate towards the apex. Legs testaceous. Length 3 mm. (in well-extended examples).

Build of *C. pedicularium*, Gr., but more robust. Head extremely finely and sparingly punctured, with short sparse yellow pubescence. Antennae rather short, 3rd joint a little longer than 2nd, 4th to 8th a little longer than broad, gradually decreasing in length, 9th and 10th as long as broad. Thorax distinctly transverse (6·5 : 4), the posterior angles rounded, extremely finely and closely punctured, finely yellow pubescent. Elytra a little longer than the thorax, narrowed behind, as long as broad, with similar puncturation and pubescence to the thorax, black, with red C-shaped mark open outwards. Abdomen very finely and densely punctured, subsericeous, with numerous long black setae at the sides and one on either side of each segment near the posterior margin.

Siwaliks; Mothronwala, Lachiwala, Kheri Rau, Nakraunda. Found amongst roots of a coarse grass growing on the sandy banks of streams.

Conosoma quadrifasciatum, n. sp.

Head black, front testaceous. Thorax rufo-testaceous, the posterior half (except the sides), and the anterior border pitchy-black. Elytra black with well-defined transverse yellow spot at the base extending to the lateral margin but not quite reaching the suture. Abdomen reddish-testaceous, the 3rd to 6th (visible) segments each with a black band. Antennae with the first three and the last two joints testaceous, the intermediate infuscate. Legs testaceous. Length 3·1 mm. (in well-extended examples).

Build of *C. suave*, Fauv., and scarcely differing in sculpture and pubescence. The antennae with 2nd and 3rd joints of equal length, 4th to 7th a little longer than broad, gradually decreasing in length, 8th to 10th about as long as broad. Thorax transverse (6·5 : 4·5), rufo-testaceous, the anterior border rather broadly and

the posterior half blackish, except at the sides, very finely, closely punctured and moderately closely yellow pubescent. Elytra as long as the thorax, transverse, rather more closely punctured than the thorax. Abdomen reddish-yellow, the 3rd and 4th (visible) segments with a broad black fascia near the posterior margins, the 5th with the fascia across the middle, 6th black, the base narrowly testaceous, the processes testaceous; pubescence yellow fine and short, not dense, and with several black setae at the sides, the 2nd to 4th (visible) segments each with erect seta near posterior margin or either side.

Siwaliks; Nakraunda. Dehra Dun. Almora; Patkria, 4500 feet above the sea.

Conosoma maculicolle, n. sp.

Reddish-testaceous, the head pitchy behind. Thorax at the base on either side of the middle with a round black spot, the anterior border very narrowly pitchy. Elytra yellow, the sides setiferous, with a rather broad, well-defined slightly oblique black band from the middle third of the outer margin to near the suture. Abdomen with the 1st and 4th (visible) segments black, the posterior margins reddish-testaceous, 2nd testaceous, more or infuscate at the base, 3rd testaceous with narrow black fascia near posterior border, 5th and 6th testaceous, with transverse dark fascia near the base. Antennae with the first five and last two joints testaceous, the intermediate black. Legs testaceous. Length 3·2 mm. (in well-extended examples).

Antennae short, the 2nd and 3rd joints of equal length, 4th and 5th a little longer than broad, 6th as long as broad, 7th to 10th transverse. Thorax transverse (6·75 : 4·75), extremely finely and moderately closely punctured, finely not densely pubescent and with a few fine erect hairs. Elytra longer (6 : 4·75) than the thorax, narrower behind, as long as broad, rather less finely and more closely punctured than the thorax, finely and moderately closely pubescent, the sides with five long black setae. Abdomen very finely and more closely punctured than the elytra, with fine short, moderately close yellow pubescence, not sericeous, the first four visible segments with erect black setae near the posterior margins, the sides and apex with similar setae.

Siwaliks; Nakraunda. Dehra Dun. Mussorie District; Arni Gad. Almorah; Dhaub China.

Conosoma quadrimaculatum, n. sp.

Ochraceous, yellow pubescent. Elytra yellow each with two pitchy spots placed transversely before the middle, one near (but not touching) the external margin, the other near the middle of the disc, the sides with long setae. Abdomen with the bases of the first four visible segments more or less blackish. Antennae short, the first five and last two joints testaceous, the intermediate pitchy. Legs testaceous. Length 3·2 mm. (in well-extended examples).

Head extremely finely, sparingly punctured, with short sparse yellow pubescence. Antennae with the 2nd and 3rd joints of equal length, 4th a little longer than broad, 5th as long as broad, 6th to 10th transverse. Thorax transverse (6·5 : 4·5) exceedingly finely and moderately closely punctured with fine, moderately close, depressed yellow pubescence. Elytra longer (6 : 4·5), than the thorax, slightly narrowed behind, as long as broad, puncturation and pubescence as on the thorax, the sides with six long black setae. Abdomen very finely and rather more closely punctured and pubescent than the elytra, not sericeous; posterior borders and sides of the segments with long black setae.

Chakrata District; Sainj Khud. Simla Hills; Fagu, Theog, Kotgarh, 6500 to 8000 feet above the sea.

Conosoma ochraceum, n. sp.

Entirely reddish-ochraceous, subconvex, finely yellow pubescent. Elytra at the sides with six long black setae. Antennae with the first five and last two joints testaceous, the intermediate black. Legs testaceous. Length 3·5 mm. (in well-extended examples).

Antennae short, the 2nd and 3rd joints of equal length, 4th to 7th a little longer than broad, gradually decreasing in length, 8th as long as broad, 9th and 10th transverse. Thorax transverse (6·75 : 4), exceedingly finely, moderately closely punctured. Elytra longer than thorax (6 : 4), narrowed behind, as long as broad, more closely punctured than the thorax. Abdomen much more closely punctured and more densely pubescent than the elytra, subsericeous, sides and posterior margins of the first four visible segments with long black setae.

Siwaliks. Dehra Dun. Arni Gad.

Table of the Above-described Species.

1\. Sides of elytra without setae . . . . 2.
— Sides of elytra with setae . . . . 15.
2\. Thorax entirely red, reddish-testaceous or blackish with transverse testaceous fascia . . . . 14.
— Thorax black, pitchy or brown, the margins often lighter . . . . . 3.
3\. Elytra dark with well-defined orange-yellow markings . . . . . 4.
— Elytra unicolorous or with obscure markings . . . . 5.
4\. Elytra with a C-shaped mark (open outwards) extending from the shoulder along the suture and the posterior margin. Antennae with first 3 joints testaceous . . . . *subgracile*, n. sp.
— Elytra with a comma-shaped mark extending from the shoulder and ending near posterior margin adjacent to the suture. Antennae with first 3 joints and the last testaceous . . . . *vittatum*, n. sp.
5\. Elytra without trace of markings . . . . 6.
— Elytra with ill-defined markings . . . . 9.
6\. Elytra distinctly longer than broad. Penultimate joints of antennae at least as long as broad . . . . 7.
— Elytra not longer than broad. Penultimate joints of antennae transverse. Length 2·75 mm. . . . . *beesoni*, n. sp.
7\. Brown species. Intermediate joints of antennae more or less infuscate *subtestaceum*, n. sp.
— Sooty-black species . . . . 8.
8\. Antennae entirely testaceous . . . . *triste*, n. sp.
— Antennae black, the first 2 joints more or less testaceous *plagiatus*, Fauv., v. *unicolor*, n.
9\. Elytra sooty black with obscure, subtriangular reddish-marking with base on the posterior margin . . . . *marginatum*, n. sp.
— Elytra otherwise marked . . . . 10.
10\. Elytra with the base (and occasionally the posterior margin) obscurely reddish . . . . 11.
— Elytra with obscure red C-shaped mark (open outwards) extending from the shoulder, along the suture and the posterior border . . . . . . 13.
11\. Basal mark of elytra extending to the side margin; posterior margin narrowly rufescent. Antennae short, the penultimate joints transverse. Small species (2·75 mm.) . . . . *obscurum*, n. sp.
— Basal mark of elytra not extending to the side margin or the suture. Larger species (3·5 to 4·5 mm.) . . . . 12.

12. Larger (4·5 mm.) and more robust; basal mark of the elytra reniform, concave behind. Antennae with first 2 joints testaceous, the rest blackish . . . . *rufoguttatum*, n. sp.
— Smaller (3·5 mm.) and more slender; basal mark of the elytra rounded. Antennae with the first 3 joints and the last testaceous . *parkeri*, n. sp.
13. Thorax scarcely transverse; species larger (4 mm.) and more robust. Antennae longer, the penultimate joints twice as long as broad *obscurevittatum*, n. sp.
— Thorax distinctly transverse; species smaller (3·6 mm.) and less robust. Antennae shorter, the penultimate joints slightly longer than broad *variabile*, n. sp.
14. Thorax entirely red or reddish-testaceous; elytra pitchy with red C-shaped marking . . . . *c-rufum*, n. sp.
— Thorax pitchy-black, towards the front with a transverse yellow fascia; elytra black with transverse yellow spot at base reaching the lateral margin . . . . *quadrifasciatum*, n. sp.
15. Species uniformly reddish-ochraceous. Antennae testaceous, the 6th to 9th joints infuscate . . . . *ochraceum*, n. sp.
— Species otherwise coloured . . . . 16.
16. Thorax at the base near the middle line with a small black spot on either side. Elytra testaceous with well-defined transverse black spot extending from the middle third of the side margin to near the suture *maculicolle*, n. sp.
— Thorax without basal spots. Elytra testaceous, each with two spots, one near the lateral margin and one on the disc . *quadrimaculatum*, n. sp.

Tachyporus nigromaculatus, n. sp.

Size and build of *T. hypnorum*, F., the antennae similarly constructed, and scarcely differing in sculpture. In well-coloured examples the head is black, the thorax testaceous more or less infuscate on the disc, the elytra testaceous with a brown, oval, oblique spot on each disc directed backwards and inwards and with the side margins blackish, the abdomen blackish with the posterior margins of the segments broadly rufescent. In other examples the head is more or less testaceous, the thorax not or scarcely infuscate, the elytral spot more or less indistinct or entirely absent with the sides concolorous, the abdomen brown with the posterior margins of the segments broadly rufescent. The antennae are blackish with the first three joints testaceous. Length 4 to 4·2 mm.

Mussorie District; Keyarkuli, Dhobi Ghat. Chakrata District: Khedar Khud. Dehra Dun. Siwaliks; Mohan Rau.

Tachyporus undulatus, n. sp.

Shining, subconvex; head black; thorax black, the posterior angles broadly, the posterior margin narrowly, testaceous. Elytra yellow, the sides narrowly black except at the postero-external angles, and with a broad undulating black well-defined fascia extending from the lateral margin to the suture across the middle of the disc, suture in front of the fascia narrowly black. Abdomen black, the posterior margins of the segments very narrowly rufescent. Antennae with the first four joints and base of the 5th testaceous. Legs testaceous. Length 3 mm.

Build of *T. chrysomelinus*, L., but differently coloured and antennae shorter. The elytral fascia leaves a reniform yellow spot at the base.

Simla Hills; Fagu, 8000 feet above the sea. Under bark.

Tachyporus assimilis, n. sp.

Of similar size and build to the preceding and with similar elytral pattern, but differs in the following respects; only the first two joints of the antennae are testaceous, the femora are pitchy-black and the tibiae brownish-testaceous, the thorax is entirely black, the posterior half of the 7th and 8th abdominal segments reddish-testaceous.

Chakrata District; Jadi Gad, 7000 feet above the sea.

Tachyporus marginalis; n. sp.

Shining, subconvex. Head black; thorax black, the sides and posterior margin narrowly, the posterior angles broadly testaceous. Elytra pitchy-black, less shining, with a large common testaceous spot occupying the postero-external angles and posterior borders and ascending along the suture for nearly half its length. Abdomen blackish, the posterior margins of the segments narrowly rufescent. Antennae pitchy, the first 4 joints testaceous. Legs testaceous. Length 3 mm. (moderately extended).

Build of *T. hypnorum*, F., the antennae similarly constructed but rather shorter, the thorax similarly marked, the elytra longer, similarly punctured, the setae longer and stronger.

Simla Hills; Gahan, 7000 feet above the sea.

Tachyporus simlaensis, n. sp.

Subconvex. Head and thorax black, shining, the sides and posterior margin of the latter narrowly testaceous: elytra black, shining, the posterior margin narrowly testaceous for the inner half, the external angles and outer half more broadly. Abdomen black, the posterior margins of the segments narrowly rufescent. Antennae blackish, the first three joints testaceous. Legs testaceous. Length 4 mm.

In build resembling *T. jocosus*, Say, but the puncturation of the elytra and abdomen less fine. Antennae with 8th to 10th joints about as long as broad. Thorax short; elytra a little longer, transverse.

Chakrata and Simla Districts, 6500 to 8000 feet above the sea.

Tachyporus singularis, n. sp.

Subdepressed. Head black, shining; thorax shining brown, the posterior margin, sides, and posterior angles broadly testaceous. Elytra greasy lustrous, depressed, brownish testaceous, the sides, a triangular scutellary mark and an obscure longitudinal mark on the disc, brown. Abdomen pitchy, the posterior margins of the segments flavescent. Antennae blackish, the first two joints testaceous. Legs testaceous. Length 3·5 mm.

Differs from all the preceding species in the broader subdepressed build and less shining elytra. Antennae long, all the joints gradually decreasing in length from the 4th, all longer than broad. Elytra distinctly longer than the thorax, a little longer than broad, very finely, moderately closely punctured. Abdomen less finely punctured than the elytra.

Chakrata District; Chulli Khud, 8000 feet above the sea.

Tachyporus ancorarius, n. sp.

Shining. Head black; thorax black, the posterior margin narrowly, the sides more or less broadly reddish-testaceous. Elytra reddish-testaceous, with an anchor-shaped black figure, the shaft along the suture, the flukes extending across the disc on either side towards the lateral margins (these infuscate except at the postero-external angles), the base narrowly blackish. Abdomen black, the posterior margins of the segments rather broadly rufescent. Antennae with the first 3 joints testaceous, the rest blackish. Legs testaceous. Length 4 mm.

A narrow, elongate subdepressed species of the build of *T. nitidulus*, F., and scarcely differing in sculpture; the antennae are, however, dark and a little longer, the 4th to 6th joints distinctly longer and the thorax a little broader.

Siwaliks; Lachiwala. Mussorie and Chakrata Districts.

Var. **nitiduloides,** n. Differs from the type form in the absence of the elytral pattern, the elytra being entirely suffused with brownish-black except the posterior margins and postero-external angles. In a long series every gradation between the type form and the variety is met with.

Mussorie, Chakrata and Simla Districts, 6000 to 8000 feet above the sea.

TABLE OF THE ABOVE-DESCRIBED SPECIES.

1.	Species in great part black or pitchy-black	2.
—	Species in great part testaceous or reddish-testaceous	7.
2.	Thorax entirely black	*assimilis*, n. sp.
—	Thorax with at least the posterior angles testaceous	3.
3.	Elytra testaceous with sharply defined black fascia extending across the suture between the lateral margins	*undulatus*, n. sp.
—	Elytra otherwise marked	4.
4.	Elytra reddish-testaceous with a common anchor-shaped mark on the disc, the lateral margins more or less infuscate at the middle	*ancorarius*, n. sp.
—	Elytra otherwise marked	5.
5.	Elytra pitchy-brown, the posterior-external angles more or less obscurely lighter	v. *nitiduloides*, n. var.
—	Elytra otherwise marked	6.
6.	Elytra black, the posterior margins narrowly testaceous	*simlaensis*, n. sp.
—	Elytra pitchy with a large common spot behind the middle at the suture and posterior margin testaceous	*marginalis*, n. sp.
7.	Species of the build of *hypnorum*, F.; elytra reddish-testaceous with an oval oblique brown spot on the disc of each or without spot	*nigromaculatus*, n. sp.
—	Species broader and subdepressed; elytra brownish-testaceous with the lateral margins and scutellary region infuscate . . .	*singularis*, n. sp.

Tachinus (s. str.) **coriaceus,** n. sp.

Broad and robust, pitchy-black, greasy lustrous, strongly coriaceous throughout, the front before the insertion of the antennae reddish-testaceous; anterior and posterior margins of the thorax narrowly, the sides more broadly obscure reddish-testaceous, the shoulders and posterior margins of the abdominal segments very narrowly and obscurely rufescent. Antennae black, the first four joints red. Legs reddish-brown. Length 7·75 mm.; breadth 3 mm.

Head strongly coriaceous, with a few fine obsolete punctures. Antennae with the 3rd joint much longer than the 2nd, 4th a little longer than broad, 5th to 7th about as long as broad, 8th to 10th slightly transverse. Thorax transverse, narrower in front, the sides evenly rounded, the posterior angles obtuse. Sculpture as on the head. Elytra a little broader and much longer than the thorax, longer than broad, the disc with traces of three or four striae, the outer one with three or four fine but deeper punctures, the rest of the surface with moderately close fine punctures, strongly coriaceous. Abdomen narrowed from base to apex, with similar sculpture to that of the elytra, but the punctures deeper.

♀. Eighth dorsal segment with median lobe semi-ovally excised; external process short, intermediate projecting a little beyond the level of the median lobe. Sixth ventral segment with median lobe feebly rounded, deeply sulcate along the middle; external process short, intermediate reaching to level of apex of central lobe.

Almorah; Kali Valley, 9000 feet above the sea. In fungus.

Tachinus (s. str.) **himalayicus,** n. sp.

Narrow, elongate, black, shining, the extreme base and lateral margins of the thorax, an indistinct spot at the shoulder and the posterior margins of the abdominal segments, obscurely reddish. Antennae black, the first two joints and occasionally the last reddish-testaceous. Legs reddish. Length 4·3 mm.

Build of *T. collaris*, Gr., but narrower, differently coloured and punctured and with shorter antennae. Head black, shining, exceedingly finely and very sparingly punctured and without ground-sculpture. Antennae with the 3rd joint slightly longer than 2nd, 4th to 6th a little longer than broad gradually decreasing in length, 7th about as long as broad, 8th to 10th transverse. Thorax transverse, extremely finely, sparingly and obsoletely punctured and without ground-sculpture. Elytra a little narrower and about one-third longer than the thorax, as long as broad, moderately closely, finely, obsoletely punctured and without ground-sculpture. Abdomen pointed, finely rather closely punctured, finely transversely strigose.

♂. Eighth dorsal segment with the middle lobe deeply triangularly excised, the lateral processes short. Sixth ventral segment very deeply triangularly excised, the excision strongly bordered except near the base; 5th ventral segment obtusely emarginate, its border studded with granules and limited on either side by a pair of short spines. ♀. Eighth dorsal segment with the median lobe with a small triangular excision, lateral processes broad, pointed, extending to the level of the apex of the median lobe. Sixth ventral segment with 6 processes, the central pair separated from one another by a semi-oval excision, the area in front deeply triangularly impressed, the apices rounded and setose; intermediate and lateral processes pointed, the lateral shortest.

Chakrata and Simla Districts, 6000 to 8000 feet above the sea.

Tachinus (s. str.) **monticola,** n. sp.

Very similar to the preceding, but the antennae longer, the penultimate joints fully as long as broad, the thorax shorter, more transverse, wider than the elytra, more closely and much more distinctly punctured, the elytra closely, finely, distinctly punctured.

♂. Eighth dorsal segment with the median lobe with much smaller and narrower excision, the lateral processes longer, almost attaining the level of the apex of the median lobe. Sixth ventral segment very deeply triangularly excised. Fifth ventral segment with a large deep semi-elliptical impression extending more than half-way between the posterior and anterior borders in the middle, the fundus

granulate, the base broadly, triangularly excised, each side of the excision with a strong spine midway between the base and apex. ♀. Eighth dorsal segment with median lobe broad, acutely pointed, the apex of the lateral process extending a little beyond the level of the apex of the lobe. Sixth ventral segment with median pair of processes rounded at apex and separated from each other by an oval excision; apex of intermediate process not extending to the level of the median ones; external processes shorter.

Simla Hills; Gahan. Chakrata District; Konain, 7000 to 8000 feet above the sea.

Tachinus (s. str.) **simlaensis,** n. sp.

Elongate, black, shining; all the margins of the thorax narrowly but distinctly red, posterior margins of the abdominal segments rufescent. Thorax very broad, practically impunctate on the disc, at the base and adjacent to the posterior angles with some fine punctures. Antennae reddish-testaceous, the 4th to the 8th, 9th or 10th joints often infuscate. Femora yellow, tibiae reddish-brown, tarsi reddish-testaceous. Length 4·75 mm.

Larger and broader than *T. monticola*, m., the thorax much broader, distinctly margined with red, the antennae differently coloured, longer, the penultimate joints a little longer than broad, the elytra less finely punctured; build of *T. brunneicollis*, m., but smaller with shorter antennae, the base and posterior angles of the thorax punctured and the elytra more strongly punctured.

Head practically impunctate and without ground-sculpture. Antennae with the 3rd joint longer than 2nd, 4th to 10th all longer than broad, gradually decreasing in length, the 10th only slightly longer than broad. Thorax much broader than long, broader than the elytra, sometimes impressed at the posterior angles, the disc with a few exceedingly fine punctures, along the base and near the posterior angles with some larger punctures. Elytra distinctly narrower and much longer than the thorax, a little longer than broad, moderately finely and moderately closely punctured. Abdomen more finely punctured than the elytra.

♂. Eighth dorsal segment with median lobe deeply semi-elliptically excised, the intermediate processes much less produced, the lateral short. Sixth ventral segment deeply, triangularly excised. Fifth ventral segment triangularly impressed, the sides of the fundus granulate, the base obtusely emarginate on either side with a small spine. ♀ unknown.

Simla Hills; Gahan, 7000 feet above the sea.

Tachinus brunneicollis, n. sp.

Head black, shining; thorax shining brown, impunctate, the lateral margins rufescent; posterior margins of the abdominal segments narrowly rufescent. Antennae black, the first two joints testaceous. Femora brownish-testaceous, tibiae pitchy. Length 5·2 mm.

Larger and more robust than the preceding, with longer and proportionately less transverse impunctate thorax, the elytra rather more finely and the abdomen much more finely punctured, the antennae distinctly longer and differently coloured. Head practically impunctate and without ground-sculpture. Antennae with 3rd joint twice as long as 2nd, 4th to 10th all distinctly longer than broad, gradually decreasing in length. Thorax strongly transverse, practically impunctate. Elytra longer and distinctly narrower than the thorax, a little longer than broad, finely, and moderately closely punctured. Abdomen very finely and moderately closely punctured.

♂. Eighth dorsal segment with median lobe deeply triangularly excised, the apex of the excision rounded, lateral processes short and stout, their apices level with the apex of the excision. Sixth ventral segment very deeply triangularly excised; 5th ventral segment broadly arcuately emarginate posteriorly, in front of the emargination crescentically impressed, the impression granulate; on either side of the emargination with a strong spine and one or two smaller ones adjacent and external thereto. ♀. Eighth dorsal segment with the median lobe divided into three long slender processes, of which the central is a little shorter and considerably more slender than the lateral and devoid of a seta; external process broad, triangular, pointed, the apex almost extending to the level of the apex of the lateral process of the median lobe. Sixth ventral segment with the two central lobes broad, rounded and shortly setose apically, separated from each other by a deep semi-oval excision, external processes long, pointed, not extending so far back as the central lobes and furnished with long and strong setae.

Chakrata and Simla Districts, 7000 to 9000 feet above the sea.

Tachinus (s. str.) **semiruber,** n. sp.

Shining, head, thorax and elytra orange-red, the first a little infuscate at the base, the latter with the suture broadly, indeterminately blackish nearly to the posterior margin. Abdomen black, the posterior margins of the segments narrowly rufescent. Antennae with the first two, three, or four joints and the last one or two reddish-testaceous, the rest blackish. Legs reddish-testaceous. Length 4 mm.

Head with a few fine punctures before the base, the rest of the surface practically impunctate. Antennae with the 4th to 9th joints longer than broad, gradually decreasing in length, 10th as long as broad. Thorax strongly transverse, finely and moderately closely punctured. Elytra longer and slightly narrower than the thorax, slightly transverse, more strongly but about as closely punctured as the thorax, occasionally the dark sutural fascia nearly obsolete. Abdomen more finely, but as closely punctured as the elytra.

♂. Eighth dorsal segment with the central lobe with a small triangular excision, the apex of the lateral process not extending to the level of the apex of the central lobe. Sixth ventral segment deeply triangularly excised. Fifth ventral segment with semi-oval impression, the fundus shining, granular, the base feebly emarginate, on either side with a short spine; 4th ventral segment with a small, smooth triangular impression in the middle of the posterior border, its base very feebly emarginate. ♀. Eighth dorsal segment with central lobe narrowly triangularly excised, intermediate process rather stout, pointed, extending to the level of the apex of the central lobe; external process short, dentiform. Sixth ventral segment with the median lobe semi-ovally excised, shortly setose.

Simla Hills; Theog, Matiana, Kotgarh, 7000 to 7500 feet above the sea.

TABLE OF THE ABOVE-DESCRIBED SPECIES.

1. Species densely, strongly coriaceous, large and robust . . . *coriaceus*, n. sp.
— Species without ground-sculpture on the fore-parts, smaller and narrower 2.
2. Fore-parts orange-yellow, the suture usually blackish in great part *semiruber*, n. sp.
— Species black, the thorax at most brown . . . . 3.
3. Base and posterior angles of the thorax with fine but distinct punctures, the disc scarcely perceptibly punctured, all the margins distinctly ferruginous . . . . *simlaensis*, n. sp.
— Thorax without larger punctures at base and posterior angles . . . 4.

4. Thorax scarcely perceptibly punctured . . . . 5.
— Thorax finely but distinctly punctured, more closely towards the base and the sides . . . . *monticola*, n. sp.
5. Penultimate joints of the antennae distinctly longer than broad. Thorax very broad . . . . *brunneicollis*, n. sp.
— Penultimate joints of the antennae slightly transverse. Thorax of normal breadth . . . . *himalayicus*, n. sp.

Coproporus himalayicus, n. sp.

Robust, convex, black, shining, the margins of the thorax and posterior margins of the elytra and of the abdominal segments often narrowly rufescent; base of the thorax with two punctures before the scutellum, otherwise entirely impunctate. Antennae infuscate, the first three joints testaceous, the last fusco-testaceous. Legs reddish-brown, tibiae darker. Length 4 to 6 mm. in extended examples.

Of the build of *C. latus*, Motsch., but the antennae are shorter and stouter, the thorax with a pair of punctures at the base as in *brunneicollis*, Motsch., and otherwise without trace of sculpture; differs from *brunneicollis*, Motsch., by the larger and more robust build, longer and stouter antennae, finer and more sparing puncturation of the elytra, coarser puncturation of the abdomen and blacker colour. The 2nd and 3rd joints of the antennae are rather long and subequal, 4th to 7th a little longer than broad, gradually decreasing in length, 8th to 10th about as long as broad, 11th stouter and a little longer than the preceding. Elytra extremely finely, sparingly punctured. Abdomen closely and extremely finely punctured. In some examples the sides of the thorax are more broadly rufescent and the sides of the elytra narrowly so.

♂. Eighth dorsal segment divided into four triangular processes, the central pair separated from each other by a deep triangular excision, the lateral extending backwards to the level of the middle of the central pair. Sixth ventral segment deeply, broadly triangularly excised. ♀. Eighth dorsal segment divided into four triangular processes, the lateral ones extending nearly to the level of the apices of the central pair, the lateral excisions deeper than in the ♂. Sixth ventral segment with six long processes, the central pair produced further backwards than the others. the apex with two or three short setae, the others each with a long apical seta.

Chakrata District; Khedar Khud, Manjgaon. Mussorie District: Arni Gad, 5000 to 9000 feet above the sea. In stream moss and débris.

Coproporus intermedius, n. sp.

Differs from the preceding in the smaller size (4 mm. in well-extended examples), narrower and more depressed build, finer, more obsolete puncturation of the elytra, shorter, darker and differently constructed antennae, which have the 4th joint about as long as broad and the 5th to 10th transverse; from *C. brunneicollis*, Motsch., by the darker, stouter and longer antennae, less sparingly punctured elytra and more finely punctured abdomen.

Simla Hills; Kotgarh. Chakrata District; Mohna, 5000 to 7000 feet above the sea. Siwaliks; Kehri Rau, Mohan Rau. In stream débris.

Coproporus monticola, n. sp.

Black, shining, subdepressed; lateral margins of the thorax and posterior margins of the abdominal segments very narrowly and obscurely rufescent Head and thorax extremely finely and moderately closely punctured, the latter without larger punctures before the scutellum. Elytra less finely and more closely punctured

than the fore-parts; abdomen closely and finely punctured. Antennae with the first four joints testaceous, the rest black. Legs testaceous. Length 4 mm. in well-extended examples.

Similar in facies to *C. melanarius*, Er., but larger and more robust, with longer elytra, finer and not quite such close puncturation of the thorax and more finely punctured elytra, the abdomen rather less finely punctured. The antennae are very similarly constructed, but rather longer, 3rd joint a little longer than 2nd, 4th to 6th distinctly longer than broad, 7th to 10th as long as broad or slightly transverse.

Mussorie District; Arni Gad. Chakrata District; Kanassar, Binal Gad. Simla Hills; Gahan, Narkanda, 6000 to 9200 feet above the sea. Under bark.

Coproporus ruficollis, n. sp.

Shining. Head and elytra black, thorax deep red, the posterior margin of the elytra and of the abdominal segments very narrowly rufescent, the 8th entirely so. Antennae with the first five joints testaceous, the rest blackish. Legs testaceous. Length 2·3 mm.

Of the size and build of *C. tachyporoides*, Kr., but differently coloured, with shorter thinner antennae, just perceptibly punctured elytra and more strongly punctured abdomen. Head without sculpture. Antennae short, slender, 2nd and 3rd joints of equal length, 4th a little longer than broad, 5th about as long as broad, 6th to 10th transverse gradually increasing in breadth. Thorax without trace of sculpture. Elytra a little longer than the thorax, narrowed behind, transverse, lateral impression broad and obsolete, sculpture exceedingly fine, obsolete and sparing; a little closer and less obsolete towards the sides. Abdomen finely, moderately closely punctured in front, less so behind; no visible ground-sculpture.

Dehra Dun. Nun Nadi.

TABLE OF THE INDIAN SPECIES OF THE GENUS *COPROPORUS*, KR.

1. Thorax and occasionally the head with coppery reflex . *cuprinicollis*, Fauv.
— Thorax without metallic reflex . . . . 2.
2. Elytra in great part black or pitchy, the margins often more or less reddish 3.
— Elytra in great part testaceous, reddish-testaceous or reddish-castaneous; the thorax in great part or entirely rufo-testaceous (except in *castaneipennis*, Kr.) . . . . 17.
3. Thorax with 2 punctures at the base before the scutellum, otherwise impunctate . . . . 4.
— Thorax without such punctures . . . . 6.
4. Antennae with 5th joint a little longer than broad. Broader and more convex. Length 4 to 6 mm. . . . . *himalayicus*, n. sp.
— Antennae with 5th joint not longer than broad. Narrower and flatter. Length 3·4 to 4 mm. . . . . 5.
5. Antennae darker, longer and stouter; elytra less sparingly punctured *intermedius*, n. sp.
Antennae lighter, shorter and thinner; elytra more sparingly punctured *brunneicollis*, Kr.
6. Antennae entirely testaceous . . . . 7.
— Antennae not entirely testaceous . . . . 8.
7. Elytra much more distinctly punctured . . . . *sanguinolentus*, Motsch.
— Elytra less distinctly punctured . . . . *flavicornis*, Kr.
8. Thorax entirely dark red; small species . . . . *ruficollis*, n. sp.

— Thorax in great part black or pitchy . . . . 9.
9. Species practically impunctate (except abdomen) . . . . 10.
— Species more or less distinctly punctured . . . . 11.
10. Elytra with ill-defined triangular reddish mark occupying the posterior margin and extending some distance along the suture . . *triangulus*, Cam.
— Elytra without such pattern . . . . *laevigatus*, Motsch.
11. Species broad and convex . . . . 12.
— Species narrow, depressed . . . . 13.
12. Fourth and 5th joints of antennae not transverse . . . . *latus*, Motsch.
— Fourth and 5th joints of antennae transverse . . . . . *holisinus*, Fauv.
13. Fifth joint of antennae transverse; minute species . . . . *atomus*, Kr.
— Fifth joint of antennae not transverse; larger species . . . . 14.
14. Penultimate joints of antennae distinctly transverse. Size smaller *minimus*, Motsch.
— Penultimate joints of antennae not or scarcely transverse. Size larger . 15.
15. Fourth joint of antennae subquadrate . . . . *planus*, Fauv.
— Fourth joint of antennae distinctly longer than broad . . . . . . 16.
16. First 4 joints of antennae testaceous. Species larger, more convex, more finely punctured . . . . *monticola*, n. sp.
— First 3 joints of antennae testaceous; species more depressed, smaller, less finely punctured . . . . *melanarius*, Er.
17. Species uniformly reddish-testaceous, glabrous . . . . *rufus*, Kr.
— Species otherwise coloured . . . . 18.
18. Thorax blackish, margins narrowly testaceous, elytra rufo-castaneous *castaneipennis*, Kr.
— Thorax entirely testaceous . . . . 19.
19. Head red, elytra testaceous with broad black well-defined basal fascia *fasciipennis*, Kr.
— Head brown, elytra testaceous more or less infuscate about the scutellum and humeral callus . . . . *tachyporoides*, Kr.

(*To be continued.*)

FURTHER RECORDS OF INSECT MIGRATION

By C. B. Williams, M.A.
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[Read March 17th, 1926.]

With Map.

On five previous occasions in the *Transactions of the Entomological Society* (1917, p. 154; 1919, p. 76; 1920, p. 146; 1923, p. 207; 1924, p. 439) I have given accounts of migrations of insects that I had observed or collected, and the present article is a further instalment of those facts, on which alone a firm foundation for the study of the migration of insects can be made.

Small notes which may appear trivial by themselves can often be of great importance when combined with other observations, and an interesting example of this is found below in the discussion on the capture of *Pyrameis cardui* in mid-Mediterranean.

Most naturalists who have travelled have observations on the migrations of insects stored up either in their note-books or their memories, and I should like to take this opportunity to appeal to such to publish the details themselves, or to let me have them for incorporation in these series of records.

The following migrations are recorded or discussed below.

(1) *P. cardui* in the Sudan in 1869.
(2) *P. cardui* at Kurkur Oasis, Egypt, in 1901.
(3) *P. cardui* in Egypt in 1924–5.
(4) *P. cardui* in Mediterranean in 1923.
(5) *P. cardui* in Iraq in 1922.
(6) *P. cardui* in Florida in 1916.
(7) *P. cardui* on W. coast of Gulf of Lyons in 1923.
(8) *P. cardui* and *C. edusa* crossing English Channel in 1899.
(9) *Catopsilia* sp.? in Mexico.
(10) *Catopsilia florella* in Egypt in Jan.-Feb. 1923.
(11) *Catopsilia florella* in Egypt in autumn 1924.
(12) *Belenois mesentina* in Egypt.
(13) *Hypolimnas bolina* in the Pacific Ocean in 1921.
(14) *Papilio machaon* in Egypt.
(15) *Agrotis ypsilon* in Egypt.
(16) Dragonflies in Egypt.

(1) *Start of a flight of P. cardui in the Sudan.*

In *Nature*, Vol. 115 (April 1925, p. 535), I gave a short summary of all the information I could collect on the movements of *P. cardui* in North Africa and Europe. I then stated, " From somewhere in, or south of, or south-east of the long line of desert stretching across North Africa and Asia Minor, the butterflies begin their north and north-westerly movement in the early spring." And again (p. 533), " Particularly just south of the Palearctic Desert Belt in Nigeria, Senegal and the Sudan, for example, every record is of the greatest

value, and anyone may help to give the clue to the mystery of the origin of the flights which reach the North African coast."

At the time of writing I had a few records in my bibliography which I had never been able to consult. Recently an opportunity occurred to look up some of these, and I found that one referred to the actual observation of the start of a flight of *P. cardui* in the Sudan, and is of such interest that I venture to quote it here in full.

The note in question is a letter by S. B. J. Skertchly, published in *Nature*, Vol. 20 (1879, p. 266), but refers to an observation made ten years previously. He writes as follows :—

" Some at least of the swarms of *V. cardui* originate in Africa, one of which I witnessed a day's march west of Sowakin in Nubia in March 1869. Our caravan had started for the coast, leaving the mountains shrouded in heavy clouds soon after daybreak. At the foot of the high country is a stretch of wiry grass, beyond which lies the rainless desert as far as the sea. From my camel I noticed that the whole mass of the grass seen seemed violently agitated, although there was no wind. On dismounting I found that the motion was caused by the contortions of pupae of *V. cardui*, which were so numerous that almost every blade of grass seemed to bear one. The effect of these wrigglings was most peculiar, as if each grass stem was shaken separately, as indeed was the case, instead of bending before a breeze. I called the attention of the late J. K. Lord to the phenomenon, and we awaited the result. Presently the pupae began to burst and the red fluid that escaped sprinkled the ground like a rain of blood. Myriads of butterflies, limp and helpless, crawled about. Presently the sun shone forth and the insects began to dry their wings, and about half an hour after the birth of the first the whole swarm rose as a dense cloud and flew away eastwards towards the sea. I do not know how long the swarm was, but it was certainly more than a mile, and its breadth exceeded a quarter of a mile."

This remarkable and unique record is an independent confirmation of the conclusions I had come to in the article mentioned above, and I much regret that I did not know of it earlier. Of course, as in most problems, it only puts us one stage further back, and we now want to know the origin of the parents of the swarm that Mr. Skertchly saw.

(2) *P. cardui in Southern Egypt.*

Dr. John Ball, Director of the Desert Survey of Egypt, has made one or two notes on *P. cardui* in Southern Egypt that he kindly allows me to quote. Any additional records from this part are important in considering the origin of the swarms as mentioned above.

At the end of January 1901 Dr. Ball visited the oasis of Kurkur, about 60 miles south-west of Asswan, and in his report (*On the Results of a Survey of Gebel Garra and the Oasis of Kurkur*, Survey Department, Egypt, 1902), p. 40, he refers to the fact that there was " a great number of butterflies of the ubiquitous painted-lady species."

Dr. Ball tells me that on one occasion in Southern Egypt he recollects seeing them hanging in such numbers on acacia trees that they looked like leaves. He cannot, however, now remember if this was at Kurkur or on a different expedition to these parts.

In January 1925 Dr. Ball visited the almost unknown Oasis of Owenat in the extreme south-west corner of Egypt, and he tells me that one or two *P. cardui*

were seen there almost every day, although there had been no rain for two years, and it is almost impossible that they had bred in the district.

Mr. T. W. Kirkpatrick visited the outlying Oasis of Siwa in the north-western desert in April 1924 and found *cardui* very abundant. It is again doubtful if they had bred in the district.

(3) *P. cardui in Egypt, September* 1924–*November* 1925.

In my last report (*Trans. Ent. Soc.*, 1924, p. 445) I dealt with the occurrence of *P. cardui* in Egypt up to September 1924. They became a little more common in October and November, and I noted them as generally common in December. January 1925 was unusually cold and practically no adults were seen, but a few larvae were found on *Malva parviflora*.

At the beginning of February more larvae were found on the same plant, but the adults remained quite rare during February and the first half of March. On the 14th March at Port Said I saw one *P. cardui* (the only one seen in two days) at 9.30 a.m. flying straight out to sea due north along the embankment at the mouth of the canal. When seen it was already north of all land, and it disappeared from sight in the same direction.

From 21st–24th March I was at the Oasis of Baharia in the desert about 150 miles south-west of Cairo, and saw a very few *cardui*, some of which were flying steadily north. And on the journey across over 200 miles of desert between Baharia and the coast, scarcely ten miles were passed without seeing a specimen of *cardui*, but without any definite flight direction being visible. It was, however, quite impossible for them to have bred in this utterly barren area.

Throughout April they remained still quite uncommon in the Cairo district, and up to the end of the month, when I left for England, *cardui* had been scarcer than any year I recollect in the district. There was most certainly no big migration through Egypt up to the end of April this year.

During my absence from Egypt from the beginning of May to the beginning of August the butterfly was carefully watched for almost every day by one of my assistants, but although several were seen early in May, only three were seen in the second half of this month and none during June or July. After my return not a single specimen was seen or reported throughout August nor until the 20th September, when I saw a single individual. Another was seen on the 4th October, and then about the 8th they began to reappear in small numbers, half a dozen or so being seen any day when a watch was kept. Up to the middle of November they were about in the same numbers.

It may be noted here also that Mr. E. Adair, living at Nîmes, in the Rhone valley, reports that he saw not a single specimen there during the month of June, and up to the end of July I have only heard of a single specimen seen in England.

In Switzerland Mr. Bainbrigge Fletcher saw a few *cardui* in the Bernese Oberland between the 23rd June and the 1st July inclusive, but not a single specimen during the remainder of July, August (at Arolla) or September (at Montreux). According to Mr. Fletcher, Mr. B. S. C. Warren caught a solitary specimen at Lausanne at the beginning of September, but saw no others during the year.

The year 1925 seems to have been one of those in which there was practically no northward flight of *P. cardui*. What was the cause, and where are we to look for it?

(4) *P. cardui captured in mid-Mediterranean in* 1923.

In my last paper on " Migration in Egypt and the Near East " in the *Trans. Ent. Soc.*, 1924, on p. 440 I gave an account of the capture of a single specimen of *P. cardui* just after midnight on the night of the 19th–20th August on board a steamer proceeding from Brindisi to Alexandria, when about one-third of the way from Crete to Alexandria.

I noted at the time that this record by itself was of little consequence, as the specimen might possibly have been on board since the ship left Brindisi, or might have flown on board the previous afternoon from Crete, which we passed within five miles. However, in May of this year I received from Mr. E. Senior White of Ceylon the following note.

" It may interest you to have a record of the occurrence of this species, *cardui*, on a homeward steamer on August 19th, 1923, about 9.45 p.m. between

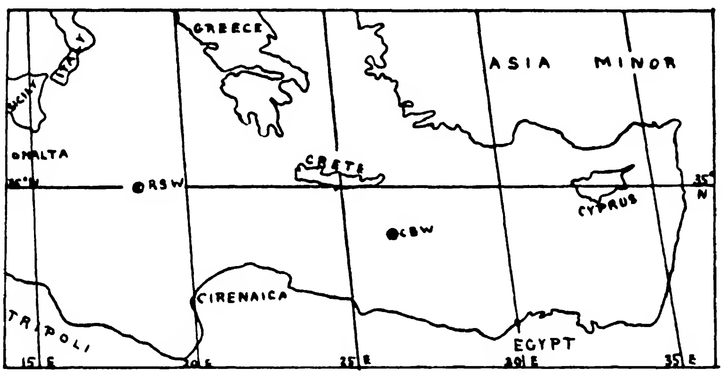

FIG. 1.—Eastern Mediterranean, showing positions in which specimens of *P. cardui* were captured on the night of the 19th–20th August, 1923 by R. Senior White (R. S. W.) and C. B. Williams (C. B. W.).

Port Said and Malta. The noon position for that day was 34° 29′ N., 21° 27′ E. The next day's 35° 46′ N., and 15° 18′ E., so the spot where the insect was seen would be nearly midway between those positions.

" It is, of course, possible that the insect came on board at Port Said, but I do not recollect seeing any butterflies during my stay in that port."

At the time of writing Mr. Senior White was unaware of my record above, and it will be seen that by a most remarkable coincidence both specimens were captured on the very same night. The two localities of my capture and Mr. Senior White's are shown on the accompanying map. They are approximately 500 miles apart.

Now, while with my record alone or Mr. Senior White's record alone, it was conceivably possible, though unlikely, that the butterfly had been on board the steamer for one or two days without being noticed; with the two records on boats going in opposite directions, one from Port Said and one from Brindisi, this explanation is too unlikely, and I think that we can justly infer that there was a thin but widespread movement of butterflies over a large area of the Mediterranean on this night, and that the specimens recorded by Mr. White and myself were individuals of this flight.

It is unfortunately quite impossible to say in which direction the flight was moving. The date, mid-August, would appear to be late for a northward movement, but as yet no flight in the reverse direction across the Mediterranean has ever been recorded.

(5) *P. cardui in Iraq in* 1922.

Mr. A. Dutt, Entomologist to the Government of Iraq (Mesopotamia), kindly allows me to record the following observation.

In March 1922 at Mosul he saw "a large number of Painted Lady butterflies (*Vanessa cardui*) coming from the desert from a south-westerly direction and laying eggs on 'Khubbaz' [*Malva parviflora*, C. B. W.] in large numbers. The caterpillars were also seen feeding in large numbers on the same plant near Shergat on the banks of the Tigris about eighty miles south of Mosul."

This is only the second record of migration from this country, and the observation that the insects were laying eggs on arrival is particularly interesting.

(6) *P. cardui in Florida in* 1916.

Mr. A. Honoré of Cairo kindly allows me to record the following information.

About the 8th, 9th, or 10th of May, 1916, when he was in a village near Key West, Florida, U.S.A., during the morning he was suddenly surrounded by a cloud of butterflies about six feet from the ground, which were so thick that they almost blinded him. The flock lasted for about twenty minutes and then disappeared as suddenly as it had come, but unfortunately he has no recollection of the direction in which they were moving. He recognised the species as *P. cardui*, as it was one of the few American butterflies with which he was familiar at home in Europe.

(7) *P. cardui on the West Coast of the Gulf of Lyons in* 1923.

Mr. N. D. Riley kindly allows me to record that in the last week of May 1923 (about the 29th or 30th) he saw large numbers of *P. cardui* passing along the coast at Banyuls-sur-Mer, Eastern Pyrenees, towards the N.N.W. The weather was fine, cool for the time of year, and as far as he can recollect the wind was a little east of south.

The butterflies were in thousands, but not in a compact cloud; they were perhaps at intervals of twenty yards or so, and always a dozen or two in sight. The flight lasted all one day from about 9 a.m. to 6 p.m., and was again noticed on the following morning.

(8) *Colias edusa and Pyrameis cardui crossing the English Channel.*

Mr. M. J. Nicoll kindly allows me to record that in August and the first half of September 1899 he frequently saw numbers of *Colias edusa* (*crocea*) and *P. cardui* coming in from the south over the sea all along the Sussex coast from St. Leonards-on-Sea to Pevensey and at Rye Harbour. The *C. edusa* were much more numerous than the *P. cardui*. They came in flying very low almost touching the sands, and usually started to appear about 8 a.m. and continued for several hours, though seldom after midday.

(9) *Yellow Butterflies in Mexico.*

I am indebted to Messrs. F. Taylor and T. W. R. Taylor for the following records of the migration of yellow butterflies (presumably *Catopsilia* spp.) on the east coast of Mexico.

Mr. F. Taylor records that on the 13th July, 1924, and for two or three subsequent days millions of yellow and white butterflies were flying towards the south at the entrance of the river about ten miles from Tampico, Mexico. Mr. Taylor tells me that he has seen similar migrations in the district on several other occasions which he cannot fix, but he has never seen or heard of a migration in the reverse (northerly) direction.

Mr. T. W. R. Taylor tells me that in April 1920, when travelling northwards for 120 to 150 miles along the coast south of Tampico, Mexico, they were surrounded by clouds of yellow butterflies all going southwards over and among the lagoons for at least two days.

(10) *Catopsilia florella in Egypt in January-February* 1923.

Mr. M. J. Nicoll kindly allows me to record that in January or February 1923, as far as he can recollect, he saw daily one to five large yellowish butterflies, which can only have been this species, all flying due east to west over the Zoological gardens at Giza near Cairo. "They used to come over the wall from the Nile and fly over my garden low and going west. The extraordinary thing about them was that they always appeared between the hours of 11.45 and 12.15, and I never saw one settle. They sometimes hovered over a patch of flowers in the garden, but usually flew straight on as if on business. So regular were they that for about ten days I used to go to the garden to watch for them."

(11) *C. florella in Egypt in Autumn* 1924.

In the *Trans. Ent. Soc.*, 1924, p. 439, I gave some notes on the occurrence of *Catopsilia florella* in Egypt. It was there pointed out that the species occurred at intervals of several years in the spring months and presumably migrated north from the Sudan, but had never been recorded later in the year. In May and June of 1924 several specimens had been seen as previously recorded (*l. c.*), and as from July to September no more were seen we presumed that the immigration flight of the year was over and that no more would be seen till another spring immigration occurred.

In the middle of October 1924, however, I was much surprised to see in a garden at Giza a large pale yellowish butterfly which I could identify as nothing but *C. florella*. A week later I saw another specimen, and on the 20th October one was captured by an assistant in the Entomological Section and definitely proved to be *C. florella*. On the 1st November I saw two more specimens, on the 5th two, on the 8th one was captured at Giza, and I saw another in Wady Digla, about ten miles south-east of Cairo. On the 11th Mr. Willcocks recorded one at Gezireh, in Cairo, and on the 6th and 17th December further specimens were seen at Giza. In addition a larva was found on *Cassia* at Giza about the 15th November and produced an adult *florella* on the 6th December.

January 1925 was exceptionally cold, but on the 28th, after two nights with frost, a friend reported seeing a large whitish butterfly at Giza which can only have been this species. On the 4th February I saw one doubtful specimen at Maadi, about seven miles south of Cairo, and on the 5th April Mr. A. Alfieri saw two near Giza. Since then no others have been seen. It most certainly

appears as if the few spring records of 1925 were either survivors or the progeny of the autumn specimens.

These are, so far as I am aware, the first autumn records of this species in Egypt, and it is impossible to say if they were the progeny of the specimens forming the spring immigration or were a new supply. The larva found in the middle of November is only the second record for this country.

(12) *Belenois mesentina in Egypt.*

In continuation of my remarks on this species in the *Trans. Ent. Soc.*, 1924, p. 447, I may say that on the 16th September, 1924, I captured a single very worn specimen at Ain Gedeirat in North-East Sinai, and that on the 6th November, 1924, one of the assistants in the Entomological Section caught one in the oasis of Kharga, about 100 miles west of Luxor.

At the time of writing the above-mentioned note I was not aware that *B. mesentina* had ever been captured in the Nile Valley, but I see that P. Graves (*Ent. Rec.*, xxxi, 1919, p. 6) records that specimens were taken near Cairo in April 1917. He says it occurred " in the desert wadies S.E. of Cairo. . . . The comparative rarity of *Capparis* in the desert S.E. of Cairo and Mr. Marshall's observations [on the migration of *Catopsilia florella* at the same time] convince me that the *B. mesentina* were immigrants from the south."

(13) *Hypolimnas bolina flying across the Sea in the Pacific.*

Through the kindness of Mr. J. Henry Watson I am able to include the following record in these notes.

Mr. William Craig sent to Mr. Watson in the early part of 1921 a number of *Hypolimnas bolina* (according to the latter, of a new unnamed race) from Fanning Island in the Central Pacific, in 4° N. and 159° W. approximately, about 134 miles N. by W. of Christmas Island, 70 miles S.S.E. of Washington Island, and about 800 miles south of Hawaii. Mr. Craig said that these were the only butterflies that he saw on the Island and the only ones known to the natives, and that while fishing four or five miles to the N.N.W. of the Island he had seen them coming in over the sea and flying towards the land. He further states that on this occasion there was a light north-easterly breeze, and that the prevailing easterly trade winds blow practically the whole year round, westerly winds coming only a few days in the year.

The nearest land to the N.N.W. is Washington Island, and beyond this there are several other islands about 300 miles away. It is probable that the butterflies were coming from some of these. If so, it is interesting to note that the flight must have continued across the wind as it was when observed, and there is no evidence that the insects were making use of the wind to aid them on their flight.

(14) *Papilio machaon in Egypt.*

There are a few recorded observations that indicate that *P. machaon* occasionally migrates far from its native home. Thus in the year 1900 it turned up in numbers in the Channel Islands, and also in many parts of England where it had never been seen before.

The occurrence of the species in Egypt is also such as to suggest that it is not a regular member of the fauna, but only an occasional immigrant. The first definite record that I can locate for this country is two specimens captured by Captain Williamson at Solloum on the coast near the Tripoli border. These were of the variety *saharae*, Oberth. (*Bull. Soc. Ent. Egypt*, v (1), p. 94, 1917).

A third specimen, of the variety *mauretanica*, was captured by Mr. M. J. Nicoll at Shallafa on the Suez Canal at the end of May 1922.

On the 26th April of this year (1925) a specimen was captured by Mr. A. Alfieri on the old desert road from Cairo to Suez about half-way to Suez (7th tower), and two others were seen on the same day. It is extremely unlikely that these could have bred anywhere in the district, or that so conspicuous a species could have been overlooked if it occurred regularly, so we are left with only the explanation that they have migrated to this country, probably, in the case of the last two records, from Palestine, where it is not uncommon. A slight confirmation of this idea is that all the specimens so far captured have been in very poor condition.*

(15) *Agrotis ypsilon in Egypt.*

In the *Trans. Ent. Soc.*, 1924, p. 450, I gave some notes on the sudden abundance of *A. ypsilon* in the desert in Egypt far away from cultivation, which supported the idea that this was a migratory insect. Since writing this two more records have come to hand, both confirming the conclusions previously reached.

Mr. O. H. Little of the Geological Survey of Egypt allows me to record that on 24th March, 1923, he arrived on the Red Sea coast from Qena (in the Nile Valley a little north of Luxor) and camped near the shore four miles south of Safaga. " Large moths were so numerous after sunset that I had to dine and work under a mosquito net."

" The moths appeared in numbers each night until we moved camp inland on the 29th March. I had to work under a mosquito net, as so many had their wings singed by the flame of the acetylene lamp that they quickly covered books, papers, etc., on the table. There were no dead moths lying about and none along the edge of the sea. This may be due to the numbers of wagtails and swallows in the district. The birds came into the tents after the moths and also caught them on the wing. Each morning about 500 to 1000 moths were found under the flaps of the tents, and when these were disturbed the birds captured every one."

Mr. Little did not keep any specimens of the moths, but when shown living specimens of *Agrotis ypsilon* identified them with absolute certainty as the species which he saw at Safaga.

The second record also refers to the same locality of Safaga (on the Red Sea coast, about 100 miles south of Suez).

Mr. G. B. Crookston (writing on April 10th, 1925) reported that " The moths first made their appearance on 22nd February during damp weather, but were quickly dispatched by a strong north wind the next day. They are here again in huge numbers and their dead bodies are to be found scattered all over the place, but not particularly on the sea shore [see below]. Of course they get attracted by the lights at night on the various verandahs, and do not seem to be able to live through more than two nights.

" The club or old office seems to be their special haunt and it is evident that they also hang round garbage pits.

" They are particularly noticeable on calm evenings or after southerly winds, which are invariably damp. A blow from the north seems to wipe them out for the moment."

And as a postscript : " I have just noticed since writing that there was

* In August 1926 the species was found to be abundant at Solloum, and over 20 adults and larvae were captured. [Note added 2.xi.26.]

to-day a considerable number of moths on the surface of the sea and on the shore. Last night [9th April] the pests were at their worst on the verandah."

Mr. Crookston sent specimens of the moth, which was *Agrotis ypsilon*.

The above are two additional facts lending strong circumstantial evidence to the idea that about the months of March and April *A. ypsilon* migrates in large numbers along the shores of the Red Sea. We have no evidence of the direction of the movement, but from the known habits of the insect we should expect it to be towards a cooler climate, *i.e.* from south to north.

In the Cairo district in 1925 I had not noticed any unusual abundance of this insect up till the 30th April, when I left for England.

In my previous account of the great numbers of this insect in the Galala Hills in April 1924 I forgot to state that, of twenty-three specimens brought back, fifteen were males and eight females, and all the females that I dissected had the ovaries undeveloped, and a large fat body filling most of the abdomen.

(16) *Migration of Hemianax eppiphiger near Cairo in* 1925.

In the *Trans. Ent. Soc.*, 1924, p. 453, I gave an account of a migration of dragonflies near Alexandria in April 1923. One of the species concerned was either *H. eppiphiger* or *Anax parthenope*, and I was at that time inclined to think the latter, as all the large dragonflies with a blue base to the abdomen that I had personally captured in Egypt up to that time had been this species. They had, however, been taken only in the autumn.

On the 18th of March, 1925, I started on a journey from Burg el Arab (about 50 miles west of Alexandria) to the Oasis of Baharia, about 200 miles to the S.S.E. across bare desert. The journey in cars took two days, and on three or four occasions we noticed large dragonflies of this type away out in the desert.

In the oasis itself a large number were seen, and several captured proved all to be *H. eppiphiger*. On the return journey to Burg on the 25th–26th March they were seen at intervals of 10 to 20 miles throughout most of the route, some being at least 100 miles from any water.

On returning to Maadi near Cairo on the 27th March I found many thousands of large dragonflies flying round, where previous to my departure ten days before there had been none.

Fortunately Mrs. R. E. Moreau had noticed the arrival of these insects, and informed me that they came about 1.30 p.m. on the 25th from the S.W. towards the N.E., mostly at a height of about ten feet. There was about one dragonfly to every square yard, but they were so active that she was unable to catch any with an improvised net. The last stragglers were seen at 5.20 p.m., but in view of the large numbers which were throughout the district in the next few days it is apparent that either the migration stopped here or that a very large number remained behind.

On the 27th March I caught in the early evening about nine males and about six females, and all were *H. eppiphiger*, and as Mrs. Moreau says that they were the same as those she saw at Kingi Mariout (*l. c.*) it is almost certain that Mr. K. J. Morton's original suggestion that this was the species concerned there was correct, though I was inclined to doubt it at the time.

The dragonflies were still about in small numbers up till the 31st March, but on the 2nd and 3rd April we had heavy hot dust-laden " Khamsîn " winds and all disappeared.

The meteorological conditions during this immigration are shown in the following table, the observations being from the Helwan observatory about seven miles south of Maadi.

March 1925.

Helwan	20	21	22	23	24	25	26	27	28
Max. Temperature °C.	19	28	31	27	25	26	28	29	25
Departure . .	−5	+4	+7	+3	+1	+2	+3	+4	0
Min. Temperature °C.	14	13	16	20	15	12	12	11	11
Departure . .	+3	+2	+5	+9	+4	0	0	−1	−1
Humidity 8 a m % .	77	90	23	59	61	71	63	24	70
Mean of Day .	73	66	20	50	46	60	42	24	30
Departure . .	+27	+19	−27	+3	−1	+13	+4	−21	−15
Wind 8 a.m. . . .	N.N.W.	N.E.	E.	N.N.W.	N.	N.N.E.	N.E.	N.N.E.	N.N.E.
Force . . .	5	5	7	6	3	3	3	2	2

It will be seen that a hot spell started on the 21st March with maximum temperatures up to 7° (13° F.) above normal and minimum temperatures up to 9° C. (16° F.) above normal, and lasting to the 27th March. The Meteorological report for the month states that "on the 22nd a third depression arrived from the western desert; early the following morning the pressure in Cairo fell 4 mm. in a quarter of an hour and a very strong easterly wind blew. Strong N.E. winds followed the passage of the depression, a velocity of 85 kilometres per hour being recorded at Helwan, and there were light showers throughout Lower Egypt. During the last week fine weather with light northerly breezes was experienced."

The migration recorded previously for April 1923 was also associated with a sudden rise of temperature.

Cairo, 14*th November*, 1925.

HOMOEOSIS AND HETEROMORPHOSIS IN INSECTS

By E. A. Cockayne, D.M., F.R.C.P.

[Read March 17th, 1926.]

Plates LXI–LXIV.

Bateson in 1894 defined Homoeosis as a variation, which consists in the assumption by one member of a meristic series of the form and characters proper to other members of the series, and said that such variations should be recognised as constituting a distinct group of phenomena. Masters many years before had applied the term Metamorphy to this class of variation in plants, but Bateson substituted his less ambiguous and more correct name. In 1891 Loeb used the word Heteromorphosis in a somewhat wider sense, and some of these remarkable meristic variations have been described under this title, but most entomologists have adopted the terminology of Bateson. Heteromorphoses or Heteroplasias, as pathologists call them, are tissues or organs formed before development has been completed, built up of normal cells arranged in an orderly manner, but situated in an anomalous position.

Although examples of homoeosis are met with throughout the animal kingdom, the most bizarre are found in Arthropods. The numerous paired appendages of their chitinous exoskeleton have been greatly modified to serve different functions, and when one of them develops in place of another it results in the production of a strange monster.

Malformations of this class, however, have a far wider interest than a mere teratological one, and indeed they are perhaps the most interesting of all malformations, because of the light they throw on the obscure laws which govern normal growth and development. At present these are still so little understood, that any line of investigation which may lead to an advance in our knowledge is well worth pursuing. Even careful descriptions of single examples may afford a clue pointing the way to some valuable experimental research. In fact, all the work done up to the present time has been initiated in this way.

Most of the records of homoeosis in insects refer to Lepidoptera, and in this Order the majority have been noticed in connection with the wings. Unfortunately the wings are very difficult to experiment upon. But it is probable that minor examples in this and other Orders are often overlooked or unrecognised.

In the following pages I am giving a list of all the cases in insects to which I have been able to find references in the literature, and I am adding descriptions of a number which have not been reported previously.

Before doing so it is necessary to make a few remarks on structure. The segmentation of the head in insects is still a subject of controversy. Most authorities believe that it consists of six somites each bearing a pair of appendages. In both Insecta and Crustacea the first somite carries the compound eyes, the second carries the antennae and antennules, and the third the intercalary appendages and the antennae in Insecta and Crustacea respectively, the fourth carries the mandibles, and the fifth the first maxillae in both, the sixth carries the labium in Insecta and the second maxillae in Crustacea. The seventh cephalic somite of Crustacea has no homologue in

insects. The nature of the compound eyes is doubtful, and they are not universally accepted as true appendages in spite of the fact that they are stalked and movable in many crustaceans.

The thorax in the Insecta is usually regarded as composed of three somites, but Sharp, on the ground that two pleural pieces are present in each, thinks there may be six. Hagen goes further, and considers that each thoracic segment is composed of three distinct somites, the anterior bearing wings, the middle bearing legs, and the posterior bearing stigmata as their respective appendages. On Hagen's supposition it is possible to regard the substitution of wings for legs, or vice versa. as a substitution of homologous appendages comparable with the other examples of homoeosis cited below.

Cephalic Appendages.

Eye (appendage of first cephalic somite) replaced by Antenna (appendage of second cephalic somite).

Drosophila melanogaster (Dipt.); squat mutation. Amongst other abnormalities the head is flat and quite often the eye has a protruding lump, which is caused by an extra antenna pushing partly or entirely through. The mutation was a dominant not sex-linked. (Bridges and Morgan.) *

Stylopyga orientalis, L. (Orthopt.), and **Tenebrio molitor**, L. (Coleopt.). Small antenna or antennae partially replacing eye after amputation. (Janda.)

Tenebrio molitor, L. Antenna replacing eye after amputation and removal of the optic ganglion in four specimens. (Křiženecký.)

Cerambyx scopolii, Füssl. (Coleopt.). Male. Both antennae were situated on the left side of the head, one in the usual place, and the other behind it on the curved surface of the eye (*in sinu oculi*). The right antennal depression was filled up with chitin. (Frivaldsky.)

Syrphus perplexus, Osburn (Dipt.). Originally described in *Science* under the name of *S. arcuatus*, Fall. There is total absence of the compound eye on the left side, and in its place is a small well-developed supernumerary antenna only lacking the arista. There is a second vertical triangle alongside of the normal one with the usual pilosity and arrangement of ocelli. (Osburn.) Injury may have caused homoeotic regeneration of an antenna instead of an eye, and in addition reduplication of the triangle.

Antennule (appendage of second cephalic somite) replaced by Mandible (appendage of fourth cephalic somite).

There is no example in insects in which the appendage of the second cephalic somite is replaced by that of the fourth, but Bateson has recorded one in the crustacean *Asellus*.

Antenna (appendage of second cephalic somite) replaced by Leg (thoracic appendage).

Halictus (Hymenopt.). Both antennae formed like legs, of which only the femora and trochanters are missing. The tibiae have spurs and the tarsi small claws. (Harling.)

Andrena clarkella, K. (Hymenopt.). Male. The antennae are asymmetrical, but both, after the proximal three segments, are leg-like and terminate in a tarsus with claws. (Wagner.)

* References will be found in the Bibliography at the end of this paper.

Zygaena (Lepidopt.). Both antennae are short and terminate in tarsal claws. (Klemensiewicz.)

Bombus variabilis, Schmkr. (Kriechbaumer), **Bombus agrorum,** Latr. (Doumerc.), and **Cimbex axillaris,** Panz. (Kraatz.) (Hymenopt.), all with one antenna terminating in a tarsus.

Carabus violaceus, L., var. **fulgens,** Charp. (Coleopt.). The right antenna has the normal number of segments, eleven, but the last is formed like the last segment of a tarsus and ends in two claws. (Gadeau de Kerville.)

Strangalia quadrifasciata, L. (Coleopt.). The left antenna ends like an imperfect fifth tarsal segment. (Przibram, 1919.)

Gastrophilus intestinalis, de Geer (Dipt.). Bedford found eight males and eleven females with antennae like imperfect legs.

Carausius (Dixippus) morosus, Brunn. (Orthopt.). After partial amputation of an antenna in several specimens the amputated portion was regenerated as a small leg ending in a tarsus with claws. The experiment was performed first by Schmit-Jensen and later by T. A. Chapman. Lucien Cuénot has repeated these experiments with the same species. He found that amputation through the proximal half of the first antennal segment was not followed by regeneration, but that, after amputation through the distal half of the first or any part of the second antennal segment, a leg was almost always regenerated and only occasionally a new antenna grew. If he amputated through the third or any of the following segments, regeneration of an antenna was the rule and that of a leg very exceptional. He thinks that homoeotic regeneration is caused by injury to the nerve supply, although there is no antennary ganglion corresponding to the optic ganglion. When he repeated his experiments on other phasmids and on mantids he obtained simple regeneration of an antenna at whatever point the amputation was carried out. Brecher's results are very similar and the legs regenerated were very complete.

Sphodromantis bioculata, Burm. (Orthopt.). After removing the antennae near the base they were regenerated, but terminated in a claw-like structure. The termination superficially resembled a foot, but no part could be clearly homologised with one. (Przibram, 1919.)

Tenebrio molitor, L. (Coleopt.). After amputation antennae, which ended in claws, were regenerated. (Tornier.)

Cimbex axillaris, Panz. (Hymenopt.). In several cases after cauterising the antennae in the late larval or nymphal stage the tip of the regenerated appendage resembled a tarsus and ended in one or two claws. (Przibram, 1919.)

Tenthredopsis nassata, L. (Hymenopt.). This is a doubtful example, in which there is a three-jointed extra appendage, more like a leg than an antenna, arising near the base of the right antenna. It is probably a case of adventitious or redundant homoeosis. (Jacobs.)

Telephorus fuscus, L. (Coleopt.). The right antenna is double beyond the third segment, and one part shows tibial and tarsal characters. (Przibram.)

Carabus festivus, L. (Coleopt.). One antenna is reduplicated distal to the seventh segment, one part being antenniform and the other ending like a tarsus. (Przibram, 1919.)

Maxilla (appendage of fifth cephalic somite) replaced by Mandible (appendage of fourth cephalic somite).

Panesthia sinuata (Orthopt.). A specimen with the right maxilla replaced by a mandible is described and figured by Shelford.

Thoracic Appendages.

Patagia replaced by wings, or prothoracic wings present.

Gelechia distinctella, Z. (Lepidopt.). An extra pair of wings, full-sized and symmetrical, arose from the prothorax and the patagia were absent. (Tarnani and H. Schultz.)

Lasius niger, L. (Hymenopt.). A rudimentary prothoracic wing is present on left side. (Wanach.)

Leg (thoracic appendage) replaced by Antenna (appendage of second cephalic somite).

Dilophus tibialis, Loew. (Dipt.). The fore coxa on the right side has a long nine-jointed extra appendage inserted on its anterior face near the distal extremity. It is probably a case of reduplication with an antenniform appendage replacing a leg, an example of redundant or adventitious homoeosis. (W. M. Wheeler and Escherich.)

Prothoracic Leg replaced by Mesothoracic Leg.

Prionus coriarius, Fabr. (Coleopt.). Female. The insect has no mesothoracic legs. The right prothoracic leg is triplicated in accordance with Bateson's Law and the left single, but these legs are in structure like mesothoracic legs. Przibram gives the name of " versatz " or translation-homoeosis to this condition, in which the normal appendage of a somite is absent, but appears instead of the appendage of another somite. (Przibram and Křiženecký.)

In crustaceans there are examples of the simple substitution of one thoracic appendage for another, and two of redundant homoeosis affecting thoracic appendages.

Metathorax replaced by Mesothorax.

Bridges and Morgan describe a recessive mutant, Bithorax, of *Drosophila melanogaster*, in which the metathorax is modified so that it resembles a mesothorax in structure. The degree of this alteration varies in different individuals, or even on the two sides of the same insect. Exceptionally one side may be normal and the other considerably modified. The abnormal somite is much larger than the normal metathorax and shows a constriction corresponding to that between the normal mesonotum and scutellum. Bristles corresponding to all the normal mesonotal bristles have been identified at one time or another, and bristles corresponding to the sternopleurals have been seen on the metapleura. The balancers (halteres) are nearly always conspicuously modified. They are swollen, darkened and hairy, and sometimes inflated so as to resemble " balloon " wings. They have minute hairs like those on the surface of the wings and heavy black hairs like those on the costa. In the best-developed specimens the extra wings are about half as large as the normal wings, and the venation is clearly like that of the normal wing. The third leg also is altered so as to resemble in some respects the second leg.

They also discovered a second quite distinct recessive mutant, Bithorax-B, in which a similar but less complete modification of the metathorax is present.

They state that the degree of modification of Bithorax is dependent on some factor or factors, probably in part at least environmental, which have not yet been investigated.

Wings replaced by Legs.

Prionus coriarius, Fabr. (Coleopt.). Male. Both elytra are replaced by legs, which are directed upwards and backwards and are inserted at the point of articulation of the elytra. The legs moved synchronously with the wings. The scutellum is absent. (Saage and Křiženecký.)

Legs replaced by Wings.

(Mesothoracic by Metathoracic.)

Melitaea maturna, L., var. **wolfensbergeri,** Frey. (Lepidopt.). The left mesothoracic leg is replaced by a tiny wing resembling the inner margin of a hind-wing. (G. Wheeler.)

(Metathoracic by Metathoracic.)

Parasemia plantaginis, L. (Lepidopt.). The hind pair of legs are replaced by miniature wings. (Woodward.)

Zygaena filipendulae, L. (Lepidopt.). The left hind-leg is replaced by a hind-wing rather small and pale, but normal in other respects. (Richardson, Bateson and Barrett.)

Leg replaced by Pencil of Hairs.

Cucullia chamomillae, Schiff. (Lepidopt.). There is a long brush of yellowish brown hairs arising in place of the right hind leg. (Przibram, 1910.) This brush is like the scent brush on the first abdominal somite.

Cases of true homoeosis affecting abdominal appendages occur in Crustacea, for instance there is a record of a *Carcinus* with a thoracic walking leg on the sixth abdominal somite. In others one abdominal appendage is substituted for another.

One part of a Leg replaced by another part.

Apion fuscirostre, F. (Curculionidae, Col.). The left prothoracic leg has a normal femur, but in place of a tibia it has another femur articulating with the first: a tibia articulates with the second femur and there is no tarsus. A femur and tibia are substituted for a tibia and tarsus. S. R. Ashby, Esher, 6.ix.1903. (Unrecorded.)

Anchomenus oblongus, F. (Carabidae, Col.). The right metathoracic leg has a femur, a tibia, a tarso-tibia and a tarsus. The tarso-tibia may be due to an attempt to form a second tibia in place of a tarsus. The influence of the normal tibia may have produced the tarsal characters of its proximal end and its tibial end may have caused the growth of an extra part, a tarsus. Its resemblance to the *Apion* has suggested this explanation, which I had not thought of, when I described and figured it in the *Transactions* for 1925.

If one excludes *Drosophila*, in which the condition is undoubtedly hereditary though modifiable in Bithorax by environment, and *Gastrophilus*, in which it may be hereditary also, and examines the remainder of these extraordinary cases of homoeosis, certain facts of interest become apparent.

In the first place, the condition is much more often unilateral than bilateral. In the second place, some substitutions are repeated many times, whereas others are very rare or do not appear at all. Finally the appendage substituted is no more often that of the somite next in front or behind than that of a distant member of the series.

Fore-wing (mesothoracic) replaced by Hind-wing (metathoracic).

Zygaena filipendulae, L. (Crocker.)

Hind-wing (metathoracic) replaced by Fore-wing (mesothoracic).

Zygaena occitanica, Vill. (Boisduval and Oberthür.)

Z. exulans, Hoch. (Wiskott.)

Z. carniolica, Scop. (Przibram, 1910.)

Z. lonicerae, Esp. (Barrett.) The specific identification of this specimen, formerly in the Capper collection and now in the Tring Museum, is doubtful. It may be *trifolii.*

Z. filipendulae, L. (Mosley.)

Z. filipendulae, L. (Grosvenor.) This specimen has no frenulum on either side. (Plate LXIV, fig. 5.)

In all the examples, so far confined to the genus *Zygaena,* which have been described fully the abnormal wing differs slightly from a normal fore-wing in shape or neuration or in both, but not more than could be accounted for by the lack of space in the pupa case for the two large wings on the one side.

Adela viridella, Scop. (Przibram.) The scaling and ciliation are like those of a fore-wing. The shape is intermediate between that of a fore- and a hind-wing, and the neuration also, but the latter approaches more closely to that of a fore-wing. A frenulum is present as in a hind-wing.

Zygaena minos, Schiff. (Rogenhöfer.) There is an additional fore-wing on the left side inserted above and between the normal wings. The shape is that of a hind-wing, the colouring that of a fore-wing. The neuration is peculiar. This is an example of redundant homoeosis.

The next and largest group, confined so far to the Lepidoptera, agrees with Bateson's definition in that one member of a meristic series, in this case one of the pair of wings, has some of the characters of another member, the other member of the pair of wings, but disagrees in that the form is unaltered. The shape and neuration are unaffected, and the only structural peculiarities are that hairs proper to the one wing may be present on the other, or may be replaced by smooth scaling where they should be present, and that, if the scales differ in structure on the two wings, their structure on the abnormal part is that proper to the corresponding part of the other wing. This phenomenon is clearly of the same nature as the complete examples of homoeosis in *Zygaena,* and the *Adela* shows a transition to these still more incomplete examples.

When one surface of a wing exhibits characters proper to the other surface of the same wing, it does not conform with Bateson's definition of homoeosis, but falls into the wider group of the heteromorphoses. But the cases which fall into this division are so closely allied to the others that I have thought it inadvisable to separate them.

Substitution of part of Fore-wing (mesothoracic) by part of Hind-wing (metathoracic).
Twenty-two examples, seventeen unilateral, five bilateral.

(1) *Upper surface affected.* Nine examples, five unilateral, four bilateral.

Arctia caia, L. Three bilateral (Mosley, Schmack), two unilateral (Frings, Shepherd).

Catocala nupta, L. One bilateral (Mosley), one unilateral (described below).

Lygris prunata, L. (Cockayne.)

Brephos parthenias, L. (Cockayne.)

(2) *Under surface affected.* Thirteen examples, twelve unilateral, one bilateral

Papilio bianor, Cram. (South.)

Papilio machaon, L. (Described below.)

Papilio horishanus, Matsumura. (Dicksee.)

Coenonympha pamphilus, L. (Cockayne and one described below.)

Melitaea athalia, Rott. Five unilateral, one bilateral. (Described below.)

Agriades coridon, Poda. (Described below.)

Eumaeus atala, Poey. (Described below.)

Substitution of part of Hind-wing (metathoracic) by part of Fore-wing (mesothoracic). Forty-two examples, thirty-seven unilateral, five bilateral.

(1) *Upper surface affected.* Twelve examples, eleven unilateral, one bilateral.

Euchloë cardamines, L. (Rye, redescribed below.)

Arctia caia, L. (Two examples, Clark, Cockayne.)

Pericallia matronula, L. (Philipps.)

Mamestra (Hadena) thalassina, Rott. (Kabis.)

Pachnobia hyperborea, Zett. (Newman.)

Taeniocampa gothica, L. (Stallman, redescribed Cockayne.)

Noctua rubi, View. (Described below.)

Noctua primulae, Esp. (Described below.)

Neuronia cespitis, Fab. (O. Schultz.)

Leucania conigera, Fab. (Smith.)

Macaria notata, L. (Bilateral, South.)

(2) *Under surface affected.* Twenty-eight examples, twenty-four unilateral, four bilateral.

Papilio glaucolaus, Bates, subsp. **melaenus,** Rothschild and Jordan. (Stichel.)

Pieris brassicae, L. (Cockayne.)

Coenonympha pamphilus, L. (Fourteen examples, two bilateral, twelve unilateral. One incorrectly described by Newman and two by Williams as instances of upperside colour on the underside, three described by Cockayne, seven described below, and one taken by Grosvenor and mislaid.)

Erebia lappona, Esp. (Two females, Sheldon.)

Epinephele jurtina, L. (Described and figured by Westwood, redescribed and discussed in *London Naturalist.*)

Hyponephele lycaon, Rott. (Described below.)

Pyrameis cardui, L. (Mentioned by Grosvenor, described below.)

Pyrameis atalanta, L. (Recorded by Buckstone and described below.)

Rumicia phlaeas, L. (Six unilateral, one incorrectly described by Corbett, Mosley and Tutt, and incorrectly figured by Mosley, redescribed by Cockayne; two described by South, one by Nostrand, one by Greer and one below; two bilateral, Frohawk, Cockayne.)

Parnassius apollo, L. (Two are described by Frings, but the surface affected is not mentioned.)

Substitution of part of the scaling of one surface of a Wing for that of the other surface. Fifteen examples.

(1) *Upper surface of fore-wing reproduced on under surface.* Four examples. Unilateral.

Agriades thetis, Rott. (One described by Pierce and one below.)

Plebeius argus, L. (**aegon,** Schiff). (One described by Barrett and one below.)

(2) *Under surface of fore-wing reproduced on upper surface.* Two examples. Unilateral.

Agriades coridon, Poda. (Described below.)

Plebeius argus, L. (Described below.)

(3) *Upper surface of hind-wing reproduced on under surface.* Six examples. Unilateral.

Agriades coridon, Poda. (Benson * and one described below.)

Morpho didius, Hpffr. (Described below.)

Morpho menelaus, L. (J. J. Joicey Coll.)

Pieris napi, L. (Described below.)

Hepialus humuli, L. (Described below.)

(4) *Under surface of hind-wing reproduced on upper surface.* One example. Unilateral.

Plebeius argus, L. (Described below.)

Erebia goante, Esp. Dr. Chapman took two specimens with upperside markings on the underside, but they were both destroyed on the journey from Arolla and were never described. It is probable that a more careful examination would have shown that they had the markings of the underside of the fore-wing on the underside of the hind-wing.

The total number of Lepidoptera with homoeosis affecting the wings is ninety. The number is too small for any safe generalisations to be made, but it is permissible to call attention to some interesting features, which these lists disclose.

In the genus *Zygaena* there are seven examples of substitutional homoeosis, and all agree in showing a complete substitution of a meso- for a metathoracic wing or vice versa, whereas there is not a single example in which the scaling alone is involved. In all the other families there is only one specimen, *Adela viridella*, in which the shape and neuration of the wing are transformed. There is one example of redundant homoeosis.

In the remaining eighty-one homoeosis is confined to the scaling. In all those I have seen, or which have been figured, it is most remarkable how exactly the colour, pattern and structure of the scales of one part of a wing are transferred to the homologous part of the same surface of the other wing or of the opposite surface of the same wing. The transference is often quite flawless and even when it is imperfect it fails only in minor details.

Of the eighty-one examples of incomplete homoeosis no less than forty-one are contributed by five species, *Coenonympha pamphilus* (16), *Rumicia phlaeas* (8), *Arctia caia* (7), *Melitaea athalia* (6), and *Plebeius argus* (4).

Although these species are favourites with entomologists who are seeking for aberrations, others collected or bred in equally large numbers have failed to provide a single example of the phenomenon. I think they have a special liability to homoeosis, and the supposition is supported by the work of Cuénot, who succeeded in producing homoeotic regeneration in almost every experiment with one phasmid, but invariably failed with another.

If the families are taken, the same irregular distribution of the abnormality is found :—Papilionidae (6), Pieridae (3), Nymphalidae (8), Morphidae (2), Satyridae (22), Lycaenidae (19), Zygaenidae (8), Arctiidae (8), Noctuidae (9), Geometridae (3), Hepialidae (1), Tineidae (1).

* From the fact that none of the spots are obliterated by the dark scales, I suspect that this is not an example of homoeosis. I have examined three similar specimens.

In certain species there appears to be a tendency for the fore-wing to be affected rather than the hind-wing, and for one surface of it to be altered rather than the other, whereas in other species a particular surface of the hind-wing is usually affected and in some cases even a particular part of it. For instance, all the *athalia* fall into one subdivision and all the *phlaeas* and all except two of the *pamphilus* into another.

The reproduction of the scaling of one surface on the opposite surface of the same wing is the rarest form of homoeosis, and yet nine of the fifteen examples are found in three species belonging to two allied genera, *Agriades* and *Plebeius*, two in species of *Morpho* and two in *Erebia goante*, unless, as I suspect, these had the colour of the underside of the fore-wing on the underside of the hind-wing.

Finally it should be noticed that, as in the more remarkable cases, in which one appendage is substituted for another, the condition usually affects only one side of the insect. Ten are bilateral, but eighty are unilateral.

Discussion of the Cause of Homoeosis.

Tarnani regarded his *Gelechia* with prothoracic wings replacing patagia as an example of atavism, and the same explanation has been put forward in the case of other specimens of homoeosis. The fact that Brogniart and others have shown that some fossil insects such as *Stenodictya lobata* had three pairs of wings has been considered a sufficient confirmation of Tarnani's view. But the prothoracic wings of the *Gelechia* are by no means primitive, appearing to be as highly specialised as the others, whereas the prothoracic appendages of *Stenodictya* are outgrowths, which scarcely deserve the name of wings at all. On the supposition that the cephalic appendages were originally locomotor in function, as some are still in the archaic *Limulus*, an antenna ending in a tarsus has been looked upon as a reversion to this primitive state. But the best developed of these homoeotic legs closely resemble normal legs, and even the imperfectly developed legs, which in some cases replaced the antennae in *Sphodromantis*, are like the highly specialised raptorial fore-legs of this insect.

The same difficulty arises in other cases of homoeosis. The claw of a crustacean is obviously a specialised walking leg, but it has been found replacing this more simple and primitive structure.

In attempting to apply this explanation to Lepidoptera insuperable difficulties are met with. For instance, the substitution of a fore-wing for a hind-wing and of a hind-wing for a fore-wing have been met with in the same species. It is almost certain that neither is like the ancestral fore- or hind-wing, and it is quite certain that both are not. The replacing of a meso- by a metathoracic wing and vice versa cannot possibly be due to atavism. Equally inexplicable in this way is the substitution of a wing for a leg.

In hereditary cases the same objection arises. In the Bithorax mutation of *Drosophila* the better developed the metathorax with its pair of wings the more closely does it agree with the mesothorax in the details of its structure. One cannot imagine that the mesothorax remained quite unaltered for the immense period of time during which the metathorax was undergoing profound modifications, the greatest being the degradation of its wings into the vestigial halteres.

The atavistic theory seems to afford an unsatisfactory explanation of any cases of homoeosis and fails completely to account for those in Lepidoptera.

There is no doubt that gross injury is the main factor in the production of

some examples of homoeosis, perhaps of the majority. But since very few injuries have this sequel, those causing it must be of such a nature as to alter the conditions during development in a special and unusual way.

The evidence with regard to injury is both direct and indirect. The indirect evidence is derived from the association of homoeosis with other abnormalities, which are known to be caused in this way.

In a *Zygaena* with a fore-wing replacing a hind-wing the other hind-wing was absent. In a considerable number of cases of minor homoeosis in Lepidoptera there is a reduction in the size of the affected wing, and in others the abnormal part of the wing membrane is crumpled. In one, in which the wing is very small, two nervures are missing in the homoeotic area and it is crumpled. In three an extra nervure runs through the affected part, and in one of these the wing is small and has a deep indentation of the margin with a perfect fringe. In another there is a bent nervure at the boundary of the homoeotic area.

In the case of absence or reduction in the size of a wing, crumpling and indentation of the margin and bending of a nervure there is experimental proof that they can be brought about by injury. Extra nervures and absent nervures are met with in association with other defects known to be due to larval or pupal injury. In the *Papilio machaon* the combination of a deformity of the genitalia, which Dr. Chapman considered to be the sequel to pupal damage, with homoeosis in a slightly crumpled wing suggests that all the abnormalities were caused by injury. The inadequate description of many specimens makes it impossible to say what proportion shows some additional abnormality, but the number is considerable, and the larger the area which exhibits homoeosis, the more frequently is some other defect encountered.

Simple reduplication of a limb has been produced experimentally in insects by amputation and crushing of the distal end of the stump, and it is probable that accidental injury is responsible for reduplicated limbs in insects captured at large, whether the reduplication be simple or homoeotic.

Homoeotic reduplication has been recorded in a Dipteron, the extra appendage being an antenna instead of a leg, and in one Hymenopteron and two Coleoptera, in which an extra leg-like structure arose from an antenna. There is also a *Zygaena*, in which an extra wing, in colour more like a fore-wing and in structure more like a hind-wing, was inserted between the two normal wings. In crustaceans there are at least two similar examples of redundant homoeosis. In the case of Vertebrates reduplication of limbs in frogs has been produced experimentally by using methods similar to those employed in insects. Quite recently Zenkewitsch has described a duck, *Anas boschas*, with a partial extra limb having webbed phalanges and a bone like that of a leg attached to one of its wings. I mention this because it shows that redundant homoeosis can occur in a Vertebrate and helps to prove that the tissues of Vertebrates and Arthropods both obey the same laws of growth. This is a matter of importance, because the chief evidence of the cause of homoeosis is derived from Vertebrate pathology.

A *Syrphus perplexus* with a reduplicated vertical triangle and an antenna in place of the compound eye on the same side, although it is not an example of homoeotic reduplication, shows us homoeosis and reduplication associated with one another.

Another point in favour of injury being a determining factor is the rarity of bilateral homoeosis. Damage is much more often done to one side of the body than to both and the resultant abnormalities are usually unilateral. In

this respect homoeosis resembles an effect of injury rather than an inborn error of development. In Lepidoptera bilateral defects of the wings due to pressure on the pupa do occur sometimes and are often nearly symmetrical. Similarly in bilateral homoeosis corresponding areas on the wings are affected. The ratio of the various bilateral defects to the unilateral ones is much the same as that of bilateral to unilateral homoeosis.

Direct proof is afforded by the experiments of Schmit-Jensen on the phasmid, *Carausius morosus*, in which amputation of an antenna was followed by regeneration of the terminal part of a leg with a small but perfect or nearly perfect tarsus. The experiment was repeated by Chapman, Cuénot and Brecher with the same result. Cuénot showed that amputation must be done through the distal half of the first or through the second antennal segment in order to obtain homoeotic regeneration, and regarded it as a sequel to an injury to the nerve supply. Przibram got a much less perfect regeneration of the same kind in *Sphodromantis bioculata.* Tornier has shown that a similar result can be obtained with the beetle *Tenebrio molitor.* Homoeotic regeneration of a different kind was obtained by Viktor Janda in Coleoptera, although his failures greatly outnumbered his successes. Of two *Stylopyga orientalis,* of which a compound eye was cut off, the first reproduced three very small antennae on the site and the second a very small antenna and a piece of facetted eye. A *Tenebrio molitor,* of which the antenna and eye of one side were destroyed, regenerated a small antenna on the site of the lost antenna and a very small antenna and a very small eye on the site of the lost eye. These experiments were carried out as far as possible without injuring the nerves. Křiženecký in his experiments on the larva of the same species removed both eye and optic ganglion and got regeneration of an antenna.

Further light has been thrown on the matter by investigations on Crustacea. As long ago as 1873 Chantran working with *Astacus fluviatilis* found that in one instance after amputating an eye an opaque bifid outgrowth was regenerated. This was evidently an antennule. Herbst has found that a more or less perfect antennule may be regenerated instead of an eye after amputation of the eye at the correct level in several species of Crustacea belonging to various families. He was successful with *Palaemon rectirostris, squilla* and *serratus, Palaemonetes varians, Palinurus vulgaris, Sicyonia sculpta, Astacus fluviatilis, Scyllarus arctus,* and *Eupagurus prideauxii.*

Morgan experimenting with *Eupagurus longicarpus,* the hermit-crab, found that after he had cut off the tips of their eyes seven out of eight regenerated a new pigment spot and sections showed that a new eye was in process of formation. Whereas out of ten which had the eye stalk cut off near the base, only five regenerated a new organ, and in all of them it was an antennule. Herbst proved that an eye was reproduced, if the optic ganglion was left intact, but that, if this structure, which is not regenerated, was destroyed, an antennule grew in place of an eye. Janda's attempt to avoid injury to nervous structures probably accounts for his poor success in the case of Coleoptera.

Homoeosis in Arthropods is closely akin to the tissue malformations known as heteroplasias or heteromorphoses. A very interesting paper on this subject has been published by G. W. Nicholson under the title "Heteromorphoses in the Human Body." In this he states that the epithelial cells of the kidney, which are not in intimate relationship with capillaries, form tubules, and that, if a proglomerulus during development fails to establish relationship with the capillaries in the normal way, a large nodule of tubules is formed instead of a glomerulus. The epithelial cells grown alone *in vitro* form an undifferentiated

sheet of embryonic tissue, but, if a piece of connective tissue be added to the culture, they arrange themselves into tubules. Thus the formation of tubules is dependent on the presence of connective tissue, and of glomeruli on the stimulus supplied by capillary blood vessels.

Another example he gives is the formation of a miniature stomach with secretory glands like those near the pylorus in the oesophagus at the level of the cricoid cartilage. A similar miniature stomach may be found sometimes at the apex of a traction diverticulum in the oesophagus at the level of the bifurcation of the trachea. The common factor in both cases is that the miniature stomach is formed in a recess, where the epithelium escapes the friction and pressure to which the rest of the developing oesophagus is subjected, and where the conditions are in this respect more like those of the developing stomach.

An extract from Nicholson's paper will make his conclusions clear. "Our observation seems to indicate that the course of evolution undergone by the cells during their development depends only in part and that a minor one on their pedigree. Quite as important, if not more so, are the stimuli that affect them. Position in the body, in relation to the surface and to other cells, appears to be the chief of these. When the stimuli are normal, but only so long as they are, the cells of a given part will inevitably assume their stereotyped forms. If they be abnormal or if the normal stimulus be absent, an abnormality of structure will as inevitably result."

There can be no doubt that heteromorphosis in man and homoeosis in Arthropods are manifestations of the same phenomenon. Any explanation which is true for one must be true for the other, and, if Nicholson be right, both are produced by abnormal stimuli acting on developing or regenerating tissue, or by the absence of a normal stimulus.

The idea is not a new one. Holmes in an article on Heteromorphosis, published in 1904, says that each cell has many possibilities and that development is not tied down to a fixed routine. He also states that the differentiation, which occurs during development, is caused by the action and interaction of cells on one another.

In the case of homoeosis in Arthropods it is probable that injury may alter the environment of a growing part in such a way that it receives stimuli more like those usually received by some homologous structure than those normal to it, or loses a stimulus essential to its proper differentiation. For instance, the presence of the optic ganglion in Crustacea provides a stimulus to the epidermal cells, which results in the growth of an eye, but in the absence of this stimulus their growth takes a different form and they produce an antennule.

The very strange mutation of *Drosophila*, in which associated with other defects there was often a small antenna situated in the middle of one or both eyes, is explicable on similar lines. It may have been due to hereditary defect of development of the optic ganglia. Unfortunately this was not investigated and the strain has been lost.

The three mutations of *Drosophila* are due without doubt to some inborn error of the germ plasm, although in Bithorax an environmental factor operates as well. Bedford's *Gastrophilus* may fall into this class, because it is improbable that so many would have been bred, had the sole cause been an external one.

The fact that homoeosis is sometimes hereditary does not militate against the view that in most insects it is acquired. Nicholson showed that in man some heteromorphoses are due to chronic inflammation and others to errors of development. It is probable, however, that even these minor develop-

mental defects, with which Nicholson has dealt, are not inborn but are due to faulty nutrition of the tissues. For the investigations of Franklin Mall have proved that even the major defects, which result in human monsters are brought about in this way.

Hereditary homoeosis is found even in mammals, and its existence forms a further link between teratology in Vertebrates and Arthropods. Cervical auricles, for example, are always present in some breeds of goats, sheep, and pigs, and occasionally several cases have been met with in one family in man, and have appeared in more than one generation.

From the examples of homoeosis, which have been given, it is evident that the cells, from which some of the appendages are developed, must possess a potentiality for producing the structure of other homologous appendages. And as one appendage becomes modified under the influence of natural selection, so the cells which form an homologous appendage acquire the potentiality to produce these modifications.

For instance, one may be sure that an antenna, even if it were formerly an organ of locomotion, never terminated in a tarsus formed exactly like the tarsus of a leg in its present form. And yet, as the tarsus by gradual changes has arrived at its present structure, so the cells, which form the antenna, have acquired *pari passu* the power to produce a tarsus with all the structural modifications complete and perfect.

Again one may be sure that in the Lepidoptera both the fore- and hind-wings have slowly changed in shape, neuration, scaling, and pigmentation, and that in the distant past a hind-wing was never like a fore-wing nor a fore-wing like a hind-wing with their present elaborate colour schemes. Yet the cells which form the scales of the hind-wing have acquired the potentiality to produce the colour and pattern of the fore-wing at its present stage of evolution, and equally those of the hind-wing have acquired the power to produce a replica of the fore-wing. It is also certain that both the upper and under surfaces of the wings have been altered gradually by evolution, and that neither surface exhibits the original arrangement of colours. Nevertheless, the colour and pattern of either surface can be reproduced on the other. *Coenonympha pamphilus* and *Arctia caia* afford examples in the same species of fore-wing pattern on the hind-wing, and hind-wing pattern on the fore-wing, on the under and upper surfaces respectively. *Plebeius argus* demonstrates that upperside markings may appear on the underside or underside markings on the upperside in the same species.

It seems to be a safe assumption, that the cells of one surface of one wing have the power to produce either the scaling proper to the same surface of the other wing, or that proper to its own opposite surface. Thus they have the potentiality to develop in two quite different directions, both of which are abnormal, as well as in the normal way.

Some substitutions of one appendage for another are much commoner than others; for instance, that of an antenna for an eye, or a leg for an antenna, are relatively common, whereas that of a mandible for a maxilla is very rare. Others are as yet unknown. But the known substitutions are so capricious in their incidence, including cephalic for thoracic and thoracic for cephalic appendages, that it seems likely that any appendage can be substituted for any other.

It is most improbable that the potentiality to develop in so many different ways is possessed only by the epidermal cells from which the appendages are formed. It can be of no value in itself, and is only revealed under abnormal

conditions. It is much more likely that all the epidermal cells inherit the same powers of growth, and that the way in which these are exercised depends on their environment during development. Only the epidermal cells have been mentioned above, because the changes in the epidermis are easily seen, but it must be remembered that the underlying mesoderm takes part in the formation of many of these abnormal growths and must have a similar power to vary. In the Bithorax mutation of *Drosophila* probably all the tissues participate.

If one admits that all epidermal cells start with the same power of response to outside influences and that their normal growth is dependent on a very delicately adjusted interplay of stimuli of different kinds, the development of a wing in place of a leg will seem little, if at all, more remarkable than that of a leg in place of an antenna, even if one rejects Hagen's suggestion that wings and legs are homologous appendages and takes the usual view that they are unrelated outgrowths.

One would also expect that an extra appendage might be found arising from a part of the epidermis, where normally there is no appendage at all. A few teratological insects of this kind are known. Reitter records a *Rhytirrhinus deformis* (Coleopt.) with a facetted eye on the thorax. Windhorst has described and figured a male *Saturnia pavonia* (Lepidopt.) with a small third antenna separated by 2 mm. from the point of origin of the normal pair, neither of which is reduced in size. Heikertinger has give a description and figure of a *Podagrica* (Coleopt.) with a monstrous third antenna arising on the left side between the clypeus and labrum, the normal antennae being perfect in size and form.

The usual explanation offered for cases of this kind is that the extra part arises from a group of cells completely separated during development from the main mass of cells, which by their further multiplication are destined to form the normal part. This hypothesis is difficult to disprove, but pathologists are becoming less and less inclined to believe in its possibility. It is more probable that they are examples of heteromorphosis, and that they afford an actual demonstration of the wonderful potentialities inherent in the whole of the epidermis and other tissues of insects.

Although experimental work has shown that regeneration of a compound eye usually requires the stimulus of an intact optic ganglion, it is unlikely that one was present in the thorax of the *Rhytirrhinus*, whether its thoracic eye arose by heteromorphosis or was transplanted from the head, so that the presence of an optic ganglion is probably not absolutely essential to the development of an eye. Similarly, if the antenna be amputated, normal regeneration appears to depend on the integrity of the antennary nerve supply, but an antenna can be regenerated instead of an eye without this stimulus. However great a part the ganglia play in causing normal regeneration, nervous influence cannot be regarded as the sole factor involved in this process.

In conclusion I wish to thank those who have helped me so readily and generously by the loan or gift of their specimens. Their names accompany the descriptions of their insects, which follow.

Descriptions.

Papilio machaon, L. Male.

Dr. T. A. Chapman's teratological coll.

There are patches of the colour and pattern of the underside of the left hind-wing on the underside of the left fore-wing. In the posterior half of cell 2 the blue marking in the

corresponding cell in the hind-wing is represented by a wedge of scales near nervure 1 and a couple of blue scales just behind the central fold. Close to nervure 1 there is a wedge of black scales with a few orange-red ones along its anterior border. This is exactly like a hind-wing marking and is pale yellow in the normal fore-wing. Internal to the black band is a patch of dark yellow scales with two black ones in the middle of it. This represents part of the inner black crescent of the hind-wing, which has dark yellow scales just internal to it, but is not an exact reproduction of the hind-wing pattern. In the anterior part of cell 1 the black extends inwards much more than in the normal fore-wing and represents the anterior part of the black crescent of the hind-wing. Internal to it are some orange-red scales and a large patch of dark yellow ones. The orange-red scales are like those in the same part of cell 2 in the hind-wing, and in this specimen no other cell has any in this situation. In the normal fore-wing the whole of this area should be pale yellow. Nervure 2 is black near the fringe as in the hind-wing. In cell 3 there is one black patch near the fringe, one in the centre of the cell, and a third touching nervure 4. These are almost exact reproductions of the markings of the same cell in the hind-wing. In cell 4 the membrane is crinkled and the inner border of the dark submarginal stripe forms a bend inwards in the concavity of which lies a blue crescent, a hind-wing marking. The anterior part of the dark marginal marking is displaced inwards and is like the anterior half of the normal black crescent of the hind-wing, and on nervure 5 is an isolated black spot, a remnant of the normal fore-wing marking. In cell 5 the outer border of the black band is displaced inwards in its posterior portion and is not like the marking of either wing. The fringe itself is black at nervure 4 as in a hind-wing. In the posterior part of the discoidal cell is a broad stripe of pale yellow running from the base almost to nervure 4 and cutting right through the proximal black bar and through part of the distal one, which is also speckled with yellow spots. This represents part of the hind-wing pattern, in which the discoidal cell has no black bars. Near the discoidal nervure there are a few black scales representing some of the black scales, which form a line along its internal aspect in the hind-wing. The specimen is labelled " appendages damaged in pupa." The anterior borders of both valves are bent outwards almost symmetrically exposing the comb-like processes, which show no distortion. The specimen is interesting in showing homoeosis of a slightly crumpled wing associated with a deformity of the genitalia, which Dr. Chapman considered to be due to damage in the pupal stage. (Plate LXII, fig. 3.)

Catocala nupta, L. Male.

W. P. Weston, Southgate, Middlesex.

Part of the colour and pattern of the upperside of the right hind-wing is reproduced on the upperside of the right fore-wing. Between nervure 1 and the posterior margin a large area of red scales occupies the position of the outer part of the pale grey band and the inner part of the dark grey band of the fore-wing, and external to it is a patch of black scales, the whole abnormal portion being 10 mm. long. Between 1 and 2 is a patch of black scales with some red ones internal and external to it; between 2 and 3 there is a very small group of red scales near the median nervure and a little black patch in the outer part of the cell. Between 3 and 4 is a thin stripe of black scales in the central part of the cell and a broader one touching 4, and internal and external to both are streaks of red scales. Between 4 and 5 is a small streak of black scales; just behind 6 extending from the disc to the termen is a stripe of abnormal scales, black then red and then black again; between 6 and 7 there is a small black streak in the inner part of the cell and a larger one in the outer part. The red scales in the outer part of the wing all lie between the inner of the two irregular toothed lines, which cross midway between disc and termen, and the outer edge of the indistinct dark band external to them, and this area is probably homologous with the wavy red band on the hind-wing. The black scales all end sharply, where the

red ones begin, and start again at the inner edge of the narrow pale grey band, which is limited externally by a row of dark loops. The wing is of full size and perfectly expanded except for a slight indentation at the abnormal area on the posterior margin. The neuration and underside are normal. (Plate LXIII, fig. 1.)

Melitaea athalia, Rott. Male.

L. W. Newman, Abbot's Wood, Sussex, 1902.

In this specimen both fore-wings show on the underside a little of the colour and pattern of the underside of the hind-wings. The wings are perfect and normal on the upperside and in neuration. The left fore-wing has a narrow stripe of silver in cell 4 cutting through the posterior part of the dark marking of the median line and corresponding in position with a part of the silver band of the hind-wing. In the posterior part of cell 5, but situated further out, is a very thin streak of pale scales corresponding with the very narrow inner part of the band of the hind-wing, which lies external to the silver band. In the right fore-wing in cell 4 there is a larger silver patch and a speck of silver in cell 5 with a dark stripe distal to it. In cells 4 and 5 two pale specks represent part of the pale band of the hind-wing, which lies internal to the silver one, and internal to the discoidal spot are two pale dots with dark scales between them. (Plate LXIII, fig. 4.)

Melitaea athalia, Rott. Male.

L. W. Newman, East Kent, vi.1922.

The pattern and colour of the underside of the left hind-wing is reproduced on the underside of the left fore-wing. Most of cell 5 from the discoidal spot out to the dark submarginal crescents shows this condition of homoeosis. From the discoidal spot outwards there is first a pale buff streak, then an irregular oval silver mark surrounded by a thin black line, and lastly another pale buff streak. There is also a thin pale stripe in the discoidal cell and a very small speck in cell 4 just external to the discoidal spot. The repetition of hind-wing pattern is a very close but not an exact copy. The wing is perfect and the neuration and upperside are normal. (Plate LXIII, fig. 3.)

Melitaea athalia, Rott. Male.

W. Crocker, East Kent, vii.1923.

Part of the pattern of the underside of the right hind-wing is reproduced on the underside of the right fore-wing. In cell 5 there is a silver stripe, which is bordered anteriorly by black scales and replaces part of the central of the three black spots. Distal to it lies a small black spot with a patch of cream-coloured scales on its external aspect. The silver stripe represents part of the silver band on the hind-wing, and the black and cream areas represent part of the narrow band between the silver band and the cream and chestnut submarginal crescents. There is no black in the hind-wing corresponding to the black scales which lie in front of the silver ones. In cell 4 is a small silver spot representing another piece of the silver band. These silver scales replace some of the black ones of the third black spot of the fore-wing. Nearer to the base of the cell are two small cream-coloured spots, and another very small one lies just internal to the discoidal spot. The last of these represents a part of the pale spot, which lies just proximal to the discoidal spot. The specimen is perfect in all respects and the neuration and upperside are normal. (Plate LXI, fig. 1.)

Melitaea athalia, Rott. Female.

W. Crocker, East Kent, vii.1923.

Part of the pattern of the underside of the right hind-wing is reproduced on the underside of the right fore-wing. In cell 5 just external to the middle one of the three black spots, which form part of the incomplete central band, is a small oval cream-coloured spot bordered by black on its outer aspect, and distal to this lies another smaller cream spot. The latter corresponds with part of one of the series of cream and chestnut submarginal crescents, and the former with part of the narrow band between the crescents and the silver band of the hind-wing. Just internal to the discoidal spot is a tiny cream-coloured speck corresponding with part of the cream-coloured marking just internal to the discoidal spot of the hind-wing. The specimen is quite perfect and the upperside and neuration are normal. (Plate LXI, fig. 2.)

Melitaea athalia, Rott. Male.

W. Crocker, East Kent.

Part of the underside of the right fore-wing shows the pattern of the underside of the right hind-wing. In cell 4 there is a patch of very pale cream-coloured scales surrounded by black ones and replacing the distal part of the oblong black spot. The pale scales are exactly like those in the broad whitish band of the hind-wing, which often has a silver sheen, but the reproduction of the pattern is imperfect. In cell 3 there is a black crescent replacing one of the indistinct submarginal spots and proximal to it lie a few dark cream-coloured scales. The latter represent those in the narrow band, which runs parallel to and outside the silver one, and the crescent corresponds to the crescent between this and the chestnut lunule. The specimen shows no other abnormality.

Melitaea athalia, Rott. Male.

W. Crocker, East Kent.

Part of the underside of the right fore-wing shows the pattern of the underside of the right hind-wing. In the middle of the basal part of cell 3 just proximal to the small black spot is a patch of cream-coloured scales corresponding with those in the narrow band, which runs inside the broad silver band of the hind-wing, and distal to it the black scales are more numerous than in the opposite wing. In all other respects the specimen is normal.

Agriades coridon, Poda. Female.

C. P. Pickett, Royston, viii.1915.

On the underside of the right fore-wing there is a stripe of the colour and pattern of the right hind-wing, which occupies the anterior part of the wing running from base to margin and extending back as far as the middle of cell 6. A thin stripe also runs through the middle of the discoidal cell. The apex of the wing is more rounded than usual and so approaches a hind-wing in shape. The costa is hairy and there are soft hairs at the base, both of which are characters belonging to a hind-wing. There is a spot and a marginal lunule between nervures 6 and 8 corresponding with those between 6 and 7 in the hind-wing; there is a lunule in the angle between 8 and 9, a very small spot and lunule between 9 and 10, and a spot between 10 and 11, markings which correspond with those between 7 and 8 in the hind-wing. Allowing for the great difference in shape and neuration in the anterior part of a fore- and hind-wing the resemblance between the homoeotic area of this wing and the anterior part of a hind-wing is very close. The upperside and neuration are normal. (Plate LXI, fig. 6.)

Eumaeus atala, Poey. Male.

H. Moore, Florida. Exhibited at the South Lond. Ent. and N.H. Soc., April 10th, 1925.

On the underside of the right fore-wing there are two brilliant metallic green spots just behind nervure 2; the one nearer to the base has a semicircle of black scales round its posterior aspect. These spots correspond with two of those on the underside of the right hind-wing, the normal fore-wing being spotless. The upperside and neuration are normal.

Euchloë cardamines, L. Male.

Labelled "Sale Stevens, 4.xii.93."

The specimen was in the collections of Sidney Webb and Arthur Horne and is figured incorrectly in Rye's *Handbook*. On the upperside of the left hind-wing there is a large orange patch filling most of the posterior part of cell 4, the whole of the marginal part of cell 3, and the anterior part of the margin in cell 2. The entire marginal part of this patch has a large admixture of black scales, and the margin itself is squarer than the corresponding part of the other hind-wing. The black scaling and the shape which are like the same part of the fore-wing are not indicated in Rye's figure. Separated from the big orange patch are two very small orange specks, one at the junction of the middle and outer thirds of cell 3 and the other in the middle of the marginal part of the same cell. The neuration and underside are normal. (Plate LXIII, fig. 2.)

Coenonympha pamphilus, L. Female.

W. Crocker, Maidstone District, vii.1925.

The colour of the underside of the right hind-wing is reproduced on part of the underside of the right fore-wing. In cell 1 irregular patches of dark scales and white hairs run out from the base along the median nervure and nervure 2 almost to the termen. Similar scales are scattered singly and in groups all over the basal three-quarters of cell 2; a large patch lies just in front of nervure 3, and there are some dark scales near the apex of the discoidal cell and along nervures 4, 5 and 6. The wing is not crumpled or reduced in size, and the neuration and upperside are normal.

Noctua rubi, View. Female.

Exeter, viii.1899, Vauncey Crewe Coll.

Part of the pattern of the upperside of the left fore-wing is reproduced on the upperside of the left hind-wing. Almost the whole of the hind-wing behind the subcostal nervure from base to termen is like the fore-wing in its dense scaling and in pattern. The reniform and orbicular stigmata are present and the dark area between them, and the dark and light transverse lines just external to the disc and those near the margin are accurately reproduced. The posterior margin is damaged, but was evidently like that of a normal hind-wing. The wing is considerably reduced in size and the outer margin is more deeply indented than usual. The neuration and upperside are normal. (Plate LXIV, fig. 6.)

Noctua primulae, Esp. (**festiva,** Schiff.). Male.

R. W. Brown, Portland, vi.1890.

The upperside of the left hind-wing shows part of the pattern and colouring of the upperside of the left fore-wing. The specimen is an aberration with that part of the fore-wings external to the orbicular a dark brown relieved by a pale submarginal line and a pale edge to the reniform. The median band and basal patch are cream coloured with

dark brown boundary lines and with some darkening of the area between, so that a broad band is formed. The hind-wing posterior to nervure 6 with the exception of a stripe along the posterior margin and thin streaks in cell 1 and in the discoidal cell is a replica of the aberrational pattern shown on the fore-wing, in which every detail is faithfully reproduced, although modified by the different shape of the cells. The abnormal wing is slightly reduced in size, narrower and with a more rounded outer margin than the other hind-wing. The neuration and underside are unaffected. The arrangement is almost exactly like that seen in the specimen of *Noctua rubi*.

Coenonympha pamphilus, L. Male.

W. Crocker, Market Rasen, vi.1925.

On the underside of both hind-wings there are areas resembling homologous parts of the underside of the fore-wings. In the right hind-wing between nervures 1*b* and 2 is a small streak of brown scales lying along the side of the ocellus and another just in front of nervure 2. On the underside of the left hind-wing there is a small spot dark brown in colour lying just behind nervure 1*b* and a similar speck near the margin half-way between 1*b* and 2. There is also a longer streak along the median nervure and a second still larger and more irregular running from the base to the ocellus between nervures 2 and 3. In all other respects the wings are normal.

Coenonympha pamphilus, L. Male.

W. Crocker, Market Rasen, vi.1925.

Parts of the underside of both hind-wings show the colour and scaling of homologous parts of the underside of the fore-wings. In the right hind-wing there is a large streak of tawny scales 4 mm. × 1 mm. running out to the ocellus and a tiny speck of dark brown scales near the margin. In the left hind-wing there are three small irregular patches between nervures 1*b* and 2. The neuration and upperside are normal and the wings are fully expanded, but the right is a little smaller than the left.

Coenonympha pamphilus, L. Male.

W. Crocker, Market Rasen, vi.1925.

The underside of the right hind-wing has in places the colour and scaling of homologous parts of the underside of the right fore-wing. There is a large irregular area of tawny colour 5 mm. long just posterior to nervure 2, and the greater part of cell 3 from the discoidal cell to the margin is occupied by large irregular patches resembling in all respects those of the corresponding parts of the fore-wing mixed with smaller areas of normal scales. The neuration and upperside are normal and the wing is not reduced in size.

Coenonympha pamphilus, L. Male.

Grayshott, May 1915, Rait Smith Coll.

The colour and pattern of the right fore-wing is partly reproduced on the underside of the right hind-wing. The abnormal parts consist of a long streak posterior to nervure 1*b*, a long streak near the base and a small spot near the margin between nervures 1*b* and 2, several irregular patches in cell 3, one in cell 4, and three specks at the apex of the discoidal cell. All the homoeotic areas correspond exactly in the character and colour of their scales with homologous parts of the fore-wing. The neuration and upperside of the affected wing are normal, but it is smaller than the other hind-wing.

Coenonympha pamphilus, L. Male.

O. R. Goodman, Hunts, 1891 or 1894.

The colour and pattern of the underside of the left fore-wing are seen on part of the underside of the left hind-wing. The wings are fully developed and there is no abnormality of neuration or upperside. Two large irregular tawny streaks scaled like a fore-wing and devoid of hairs run through the discoidal cell from its base to its apex. In cell 3 a tiny strip of the same colour crosses from the discoidal cell, and there are two more very small specks near the margin. In cell 4 there is a broad tawny stripe running almost to the margin, replacing half the ocellus and filling the cell completely just beyond it. Rather more than half of the proximal third of cell 5 is occupied by scales in colour and pattern like those of the corresponding part of the fore-wing. In cells 4 and 5 the tawny areas show a darker band running transversely, which represents the dark band of the fore-wing internal to the ocellus, and as in the fore-wing the scales just external to the band are paler than those further out. There is a very narrow line of darker scales running obliquely outwards and backwards from the dark transverse line in cell 5. It appears to be part of the dark outer halo of the big eye-spot of the fore-wing, which does cross into cell 5. Unfortunately cell 6, which contains the greater part of the big spot in the fore-wing, is normal in the hind-wing. (Plate LXI, fig. 9.)

Coenonympha pamphilus, L. Female.

T. H. L. Grosvenor, Reigate, 22.vi.1920.

Part of the underside of the right hind-wing has the colour of the underside of the right fore-wing. In cell 3 there are three small spots of tawny colour like the ground-colour of the fore-wing, and in cell 2 there is another small tawny spot lying just within the dark basal area. The specimen is worn, but is perfectly developed and normal on the upperside and in neuration.

Coenonympha pamphilus, L. Male.

O. R. Goodman, Theydon Bois, 2.vi.1923.

On the underside of the left hind-wing near the margin between nervures 1 and 2 there is a small wedge-shaped area of chocolate-brown scales like those of the submarginal band on the underside of the fore-wing, and another thin strip along nervure 2. In cell 2 there is a large area of pale tawny scales occupying most of the basal two-thirds of the cell, and in cell 3 there are two smaller ones lying nearer to the margin. The wing is perfectly formed and the neuration and upperside are normal.

Hyponephele lycaon, Rott. Female.

F. A. Oldaker, La Grave, 12.viii.1922.

The colour and pattern of the underside of the left fore-wing is present on part of the underside of the left hind-wing. In the discoidal cell there is a large fulvous area. In cell 2 there is another fulvous patch in the centre of which is a black spot with a white centre. This corresponds with the posterior ocellated spot of the fore-wing which also lies in cell 2. In the anterior part of cell 3 there are two small fulvous spots, and in cell 4 another one fills the whole width of the cell, and in its anterior part touching nervure 5 is a small oblong black spot with a white centre. This part of cell 4 in the fore-wing is occupied by the posterior part of the anterior spot, but in this specimen it has no white pupil. The condition is identical with that in Mr. Mera's homoeotic *pamphilus*. (Plate XLI, fig. 9.) In some Satyridae such as *E. tithonus* the big ocellus nearly always has two white pupils, one in cell 4 and one in cell 5. In *P. megera* this is fairly common, and occasionally there

are two separate ocelli. In neither the *lycaon* nor the *pamphilus* is this part of the hind-wing a replica of the fore-wing, but I regard the small ocellus in both of them as homologous with the posterior part of the big ocellus of the fore-wing which lies in cell 4. It would be a good copy of the corresponding part of the fore-wing of some Satyrids, although it is not a good copy of its own. In the posterior part of cell 5 there is a long thin fulvous streak, but it does not extend outwards as far as the part in which an ocellus would be expected to appear. The wing is fully developed and there is no abnormality of neuration or upperside markings. (Plate LXI, fig. 10.)

Erebia lappona, Esp. Two females.

W. G. Sheldon, Porsanger, 28 and 30.vi.1912.

In cells 2, 3, 4 and 5 and in the discoidal cell on the underside of the right hind-wing there are patches of red-brown scales like those on the underside of the right fore-wing, small in the first and extensive in the second. In cell 4 of both specimens there is an ocellus like that of the fore-wing. The big patch in cell 2 of the first is dull brown like the corresponding part of the fore-wing. The small hairs on these abnormal parts prove that the scaling is underside not upperside in character. In both the neuration and upperside are normal and the development perfect. (Plate LXI, figs. 4 and 5.)

Pyrameis cardui, L. Male.

T. H. L. Grosvenor, Thal Tribal Territory (Kurram Valley), N.W. Frontier, India, vi.1918.

Part of the underside of the left hind-wing shows the colour and pattern of the underside of the left fore-wing. The left hind-wing is considerably smaller than the right and is imperfectly expanded. It has an extra nervure and a deep indentation of the margin. Cell 1 shows an almost perfect reproduction of the colour and markings of the corresponding part of the fore-wing. This is also true of cell 2 except that normal markings are present in the anterior third of the distal half. Cell 3 has the proximal part like a fore-wing with its black mark between nervure 2 and the median nervure, and a little black spot near the middle of nervure 2 representing that part of the big black mark in cell 2, which crosses into and encroaches on cell 3. Beyond this the stripe of fulvous ground-colour narrows, but cuts into the outer black ring of the ocellus. Cell 6 is bisected by an extra nervure and a narrow oblong ocellus lies in each of the divisions so formed. The margin is deeply indented in the posterior division, but has a fringe. The anterior half of the posterior division is a perfect replica of the corresponding part of the fore-wing. It has two dark marks separated by a narrow pale transverse line, distal to which is a whitish mark bordered externally by a very thin blackish line. The small size and imperfect expansion, the fringed indentation of the border and the extra nervure near it are all abnormalities, which can be safely regarded as due to pupal injury. The upper side is normal. (Plate LXIV, fig. 1.)

Pyrameis atalanta, L. Male.

A. A. W. Buckstone, Wimbledon. Bred August 1923.

The underside of the left hind-wing shows in places the colour and pattern of the underside of the left fore-wing. This wing is very small, measuring only 3·3 cm. in length and 3 cm. in width, instead of 4·3 and 4·2 cm., and two nervures are missing, apparently 3 and 6. In the discoidal cell just distal to the dark basal blotch is a small patch of bluish violet scales of the same colour and in the same position as some of those in the fore-wing. Further out are four small patches of red scales, the innermost replacing part of the second basal blotch and therefore not corresponding with any red mark on the fore-wing, the other

three lying between the second and third basal blotches and so corresponding to the basal red mark on the fore-wing. In the area between nervures 2 and 4 there is a fairly broad but broken oblique band of red scales, which become yellower in tint near the margin. Distal to them black scales extend to the margin, and a triangle of black scales lies just in front of nervure 2. Allowing for the absence of a nervure all these markings agree with those on the fore-wing. Between nervures 1 and 2 and just behind the latter there is a band of black scales bordered posteriorly by a narrow line of red ones. There are no corresponding red scales in this part of the fore-wing, which is entirely black. Owing to the abnormal shape and neuration the whole pattern of the hind-wing differs slightly from that of the opposite one, and the space between nervures 2 and 4 is a little crinkled. Except that the left fore-wing is rather narrower than the right the remaining three wings are perfect in every respect, and the upperside is normal. (Plate LXIV, fig. 2.)

Rumicia phlaeas, L. Male.

F. W. Frohawk, Thundersley, 1.vi.1920.

The greater part of the underside of the left hind-wing posterior to the middle of the discoidal cell is like the underside of a fore-wing. The posterior portions of the basal and central spots in the discoidal cell and of the discoidal spot itself are black with a pale ring like those of the fore-wing, but are much smaller. The spots in cells 1, 2 and 3, and the anterior half of that in cell 4 are black like those of the fore-wing, and, although they differ in shape, they occupy the corresponding positions accurately. Of the three blackish marginal markings of the fore-wing the last two are completely represented in the hind-wing, but only the posterior part of the first is present. The bright orange ground-colour shading into golden yellow is a true copy of the fore-wing. The silvery scales along the hind margin and the wedge of dark scales running out from the base in cell *1b* reproduce perfectly those of the fore-wing. A stripe of normal scales runs along the median nervure and another runs from the discoidal spot widening as it approaches the termen, and small patches are visible in cells 2 and 3. On the underside of the right hind-wing there is a narrow stripe of golden yellow scales in cell 4. The neuration and upperside are normal in both hind-wings, but the left is reduced in size. (Plate LXI, fig. 8.)

Rumicia phlaeas, L. Male.

A. E. Stafford, East Sheen, 9.vi.1924.

On the underside of the right hind-wing there is a large area with the colour and pattern of the underside of the right fore-wing. The outer part of the discoidal cell, the greater part of cells 1, 2, 3 and 4, and the posterior part of cell 5 show the orange ground-colour of the corresponding part of the fore-wing. In the discoidal cell the outer of the two black spots is larger than that in the opposite wing and has a few orange scales round it. The posterior half of the discoidal spot and the spots in cells 1, 2, 3 and 4 are in size, colour (black with a pale encircling ring), and position almost exactly like those of a fore-wing. The dark margin also resembles that of the fore-wing. There is a very small spot in cell 4, and large ones in cells 2 and 3. There is little doubt that the fore-wing pattern extended to the whole margin of cell 1, but a piece has been chipped out. The wing is a little smaller than the other hind-wing and is slightly curled. The neuration and upperside are normal. (Plate LXI, fig. 3.)

Agriades thetis, Rott. Male.

L. W. Newman, Folkestone, ix.1923.

There is a narrow interrupted stripe of rounded blue scales of the upper layer with blackish scales of the lower layer but without androconia, running from the extreme base

of the wing through the middle of the discoidal cell and cell 7, on the underside of the right fore-wing. These scales, which in shape and colour resemble those of the upperside, replace the white ones of the front part of the anterior basal and the discoidal spots, and those on both sides of the anterior spot of the submedian row as well as the buff scales of the ground-colour. There are black scales along the sixth nervure near the margin spreading laterally at the margin itself, and more black scales on the margin in the middle of cell 7. These occupy the same position as the black scales of the marginal line on the corresponding part of the upperside. The neuration and upperside of the wing are normal, but the affected part of the wing is narrower than its counterpart.

Plebeius argus, L. (**aegon,** Schiff.). Male.

H. A. Leeds, Kent, 15.vii.1924.

Almost all the underside of the right fore-wing behind the discoidal spot is dull purple. Thin streaks of normal colour run through the homoeotic area, but the only remaining spots are the two small ones at the posterior angle. On the dark part of the wing the scales are like those of the upperside. Those at the margin are black, like those forming the black border on the upperside. Over the rest of the area there is a complete lower layer of blackish-brown scales and a partial upper layer of blue ones rounded or serrated at the tips. Androconia are present, but deficient in numbers. The presence of androconial scales, more than fifty of which were counted, on the underside of the wing is most interesting and affords convincing evidence that the scaling is in all respects like that of the upperside. The specimen is a large one in perfect condition. The abnormal wing is equal in size to that on the opposite side, is fully expanded, and has a normal neuration and upperside. (Plate LXIV, fig. 3.)

Agriades coridon, Poda. Female.

C. P. Pickett, Royston, viii.1923.

On the upperside of the left fore-wing there is a black discoidal spot larger than that on the opposite side, but the same size as that on the underside and with a similar ring of white and pale blue scales around it. In cell 6 there is a small black spot surrounded by a white ring and another in cell 5. In the anterior part of cell 4 there is a black spot with a white semicircle just in front of it. Scattered buff scales, like those of the ground-colour of the underside, lie externally to all three spots. The spots belong to the submedian series, but are smaller than the corresponding ones on the underside, and lie so much nearer to the disc that viewed by transmitted light their outlines do not overlap. In all three cells 6, 5 and 4 there is a small pale marginal lunule with a crescent of dark brown scales internal to it. They are smaller than those on the underside. The tip of the left fore-wing is slightly crumpled, but the underside and neuration are normal. (Plate LXI, fig. 7.)

Plebeius argus, L. (**aegon,** Schiff.). Female.

H. A. Leeds, Kent, 16.vii.1924.

This shows some underside pattern on the upperside of the left fore-wing. Between nervures 1 and 2 there are blackish scales just internal to the orange lunule and a sprinkling of white scales spreads inwards from them. The double black spot is present a little nearer to the base, and is partially ringed with white. Between nervures 3 and 4 the posterior half of the orange lunule has blackish scales internal to it, and just inside these lies a single white one. Internal to the anterior half of the lunule there are three white scales. The anterior part of the black spot between these nervures is present, and has white scales both internal and external to it. Between nervures 5 and 6 there is a blackish spot

just internal to the orange lunule, and a very distinct streak of white runs from it towards the base. In the position of the spot there are a considerable number of black and nine white scales. Just in front of nervure 7 there is a single white scale. All the markings correspond exactly in position with those on the underside, but the spots are much smaller. The size, development, neuration and underside of the wing are normal.

Plebeius argus, L. (**aegon**, Schiff.). Female.

E. Crisp, Ashdown Forest, vi.1921.

Part of the underside pattern of the left hind-wing is present on the upperside. The greater part of cell 1*a* is occupied by blackish and pale blue scales like the same area on the underside, but there is no spot, no lunule and no white area between them. The outer half of cell 1*b* is in all respects like the corresponding part of the underside. From within outwards there is a black spot encircled with white, a white band, two black crescents, two orange spots, two small black spots and then the white margin. Cell 2 has a strip of white in the position of the white border and black specks representing the posterior part of the black submarginal markings, and there is also the anterior part of the black marginal spot. In cell 3 there is a similar white stripe, and external to it lies the apex of the black submarginal crescent. In cell 4 part of the outer row of black spots is represented and a large white splash corresponds to a part of the white band. Outside this is a black mark larger than the normal submarginal crescent. In cell 5 there is another piece of the white band and external to it are two black spots agreeing neither in position nor in shape with any part of the submarginal crescent or marginal black spot. In cell 6 there is part of the marginal black spot. Thus a considerable area of the outer half of the wing resembles an underside. The thin white borders to the marginal spots are much more conspicuous than those of the right hind-wing, but not nearly as broad as those of the underside. In spite of slight differences the markings agree in their main features with those of the corresponding parts of the underside. Along nervures 6 and 7 and in the anterior part of cell 5 there are stripes of black scales mixed with rounded blue ones, but without androconia. These are not present normally on either surface. It is a homoeotic specimen of ab. *inaequalis*, Cockayne. The neuration, underside and development are perfect. (Plate LXIV, fig. 4.)

Pieris napi, L. Male.

H. Worsley Wood, Cambridge. Bred 4.v.1923.

Part of the underside of the left hind-wing shows the colouring of the upperside. In the discoidal cell touching the subcostal nervure two small groups of white scales replace the yellow ones of the central part or the grey and yellow ones of the parts adjoining the nervures. These white scales extend out to the margin in cell 6, and occupy a part of the wing, which is yellow on the underside of the fore-wing. This area is white on the upperside of the hind-wing. The blackish spot in cell 6 has more black scales than that of the right hind-wing and is thus more like an upperside spot. The wing is perfect and the upperside and neuration are normal. The larvae were not disturbed during pupation unless by other larvae, and the pupae were not moved. (Plate LXII, fig. 1.)

Hepialus humuli, L. Male.

McArthur, I. of Lewis, 1901. Robert Adkin Coll.

On the dark brown underside of the left hind-wing there is a large oval patch of white scales like those of the upperside. It runs almost transversely across the wing between the discoidal and the termen from 4 to 10. There are a few brown scales scattered amongst the white ones. The specimen is normal in all other respects.

Agriades coridon, Poda. Female.

W. Crocker, Royston, viii.1925. No. 33793.

Part of the underside of the left hind-wing is clothed with scales resembling those of the upperside. An area covered with blackish brown scales spreads out from the base filling the greater part of the space between the posterior margin and nervure 1, but stopping short of the basal spot. It fills the space between 1 and the median nervure and the proximal part of 2, replacing the anterior half of the spot of the median row and sending a streak out nearly as far as the marginal lunule, and also occupies the basal part of the cell between 2 and 3, replacing the posterior three-quarters of the spot of the median row and running out as a dark stripe to the level of the marginal lunule. There are similar scales scattered singly and in small groups in the discoidal cell and between 3 and 4, some of which replace the white ones of the ring surrounding the spot of the median row in cell 3. Thin lines and single scales of normal colour break up the main area, and in its outer part the hairs, which lie thick on both upper and under surfaces in this region, are almost absent. It differs from the corresponding part of the upperside in this respect and in tne darker colour of the scales, but the obliteration of one spot and parts of three others is strong evidence that it is an example of homoeosis. The upperside, neuration and size of the wing are normal and it is fully expanded.

Morpho didius, Hpffr. Male.

Lamercen, Peru. J. J. Joicey Coll.

Part of the underside of the right hind-wing shows the colour of the upperside. There is an extra nervure arising between 5 and 6, which ends after a course of 21 mm. before reaching the margin. Between the end of the nervure and the margin the wing membrane is a little crumpled. On either side of the extra nervure there is a streak of brilliant blue scales 30 mm. long by 5 mm. wide at the widest point. Just internal to the marginal stripes is a triangular patch of black scales with its apex towards the base of the wing. There are a few small groups of blue scales in the discoidal cell. The shape of the blue scales is quite different from that of the brown scales of the underside, but both in colour and shape they are exactly like the iridescent blue scales of the upperside. The upperside and size of the wing are normal. There is a similar specimen of *Morpho menelaus*, L., a male, also in the Hill Museum. (Plate LXII, fig. 2.)

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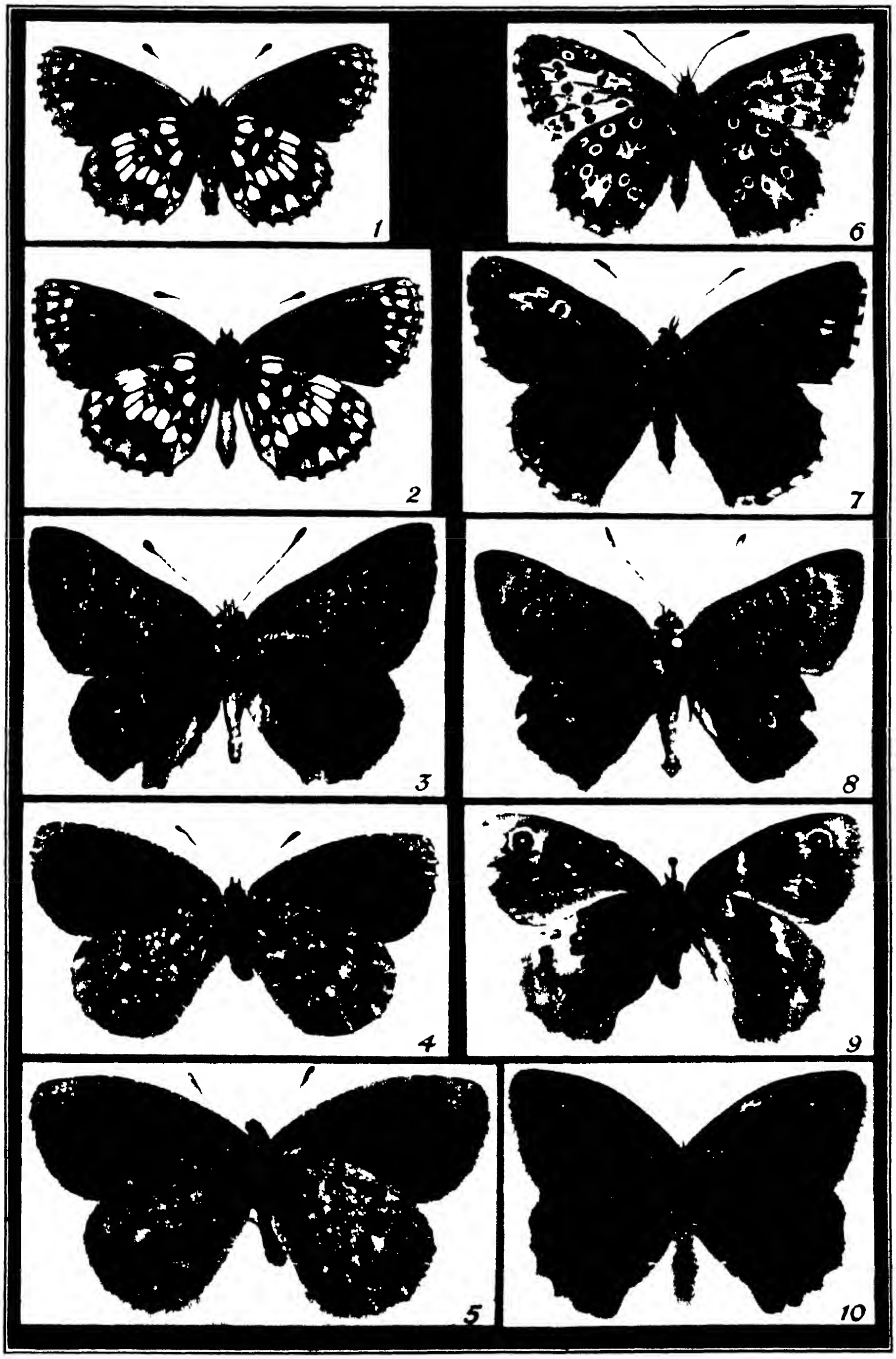

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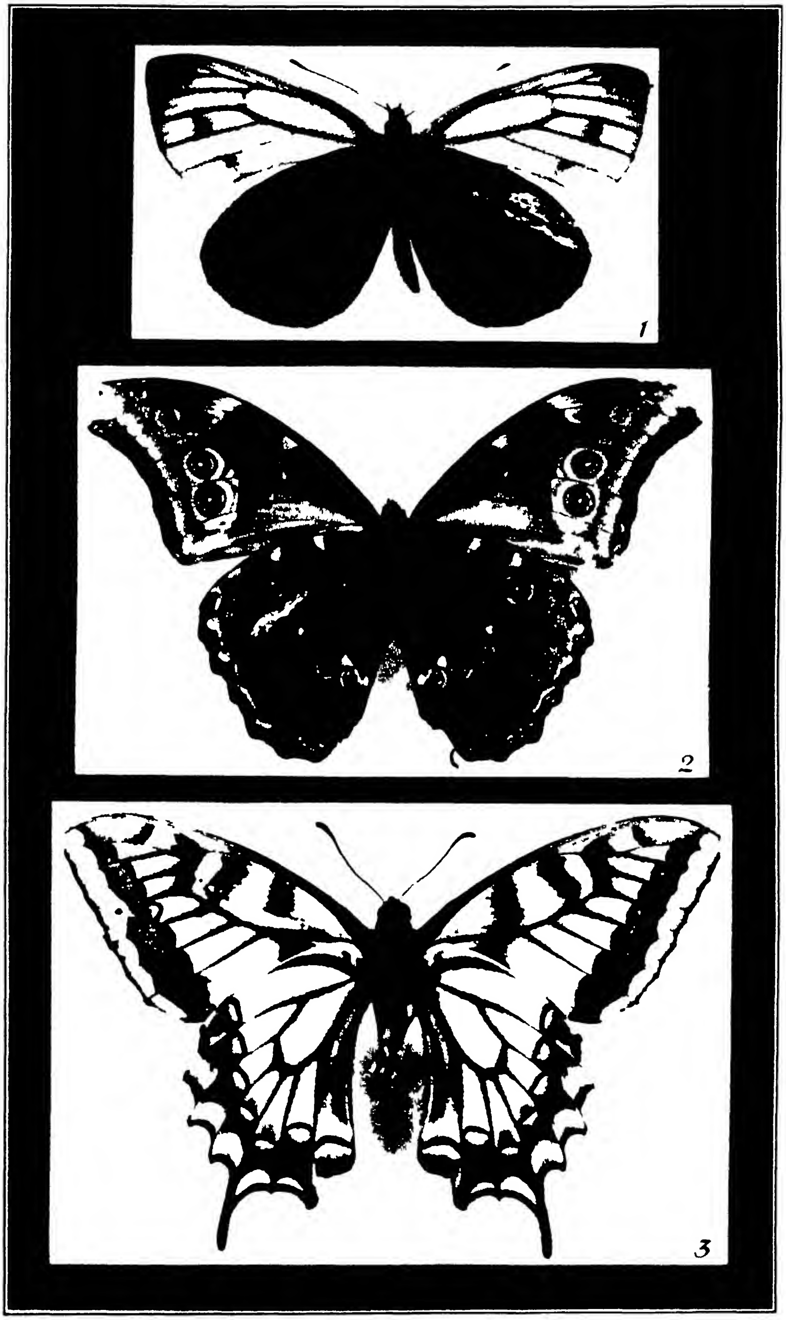

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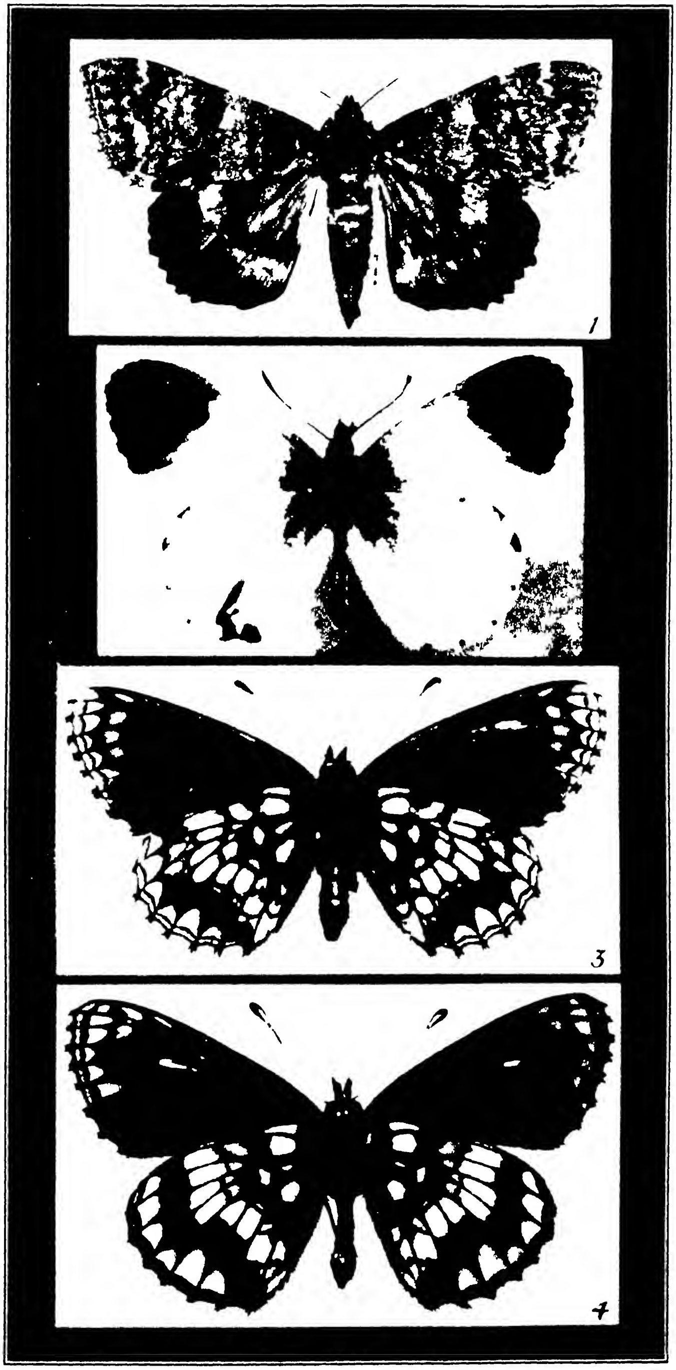

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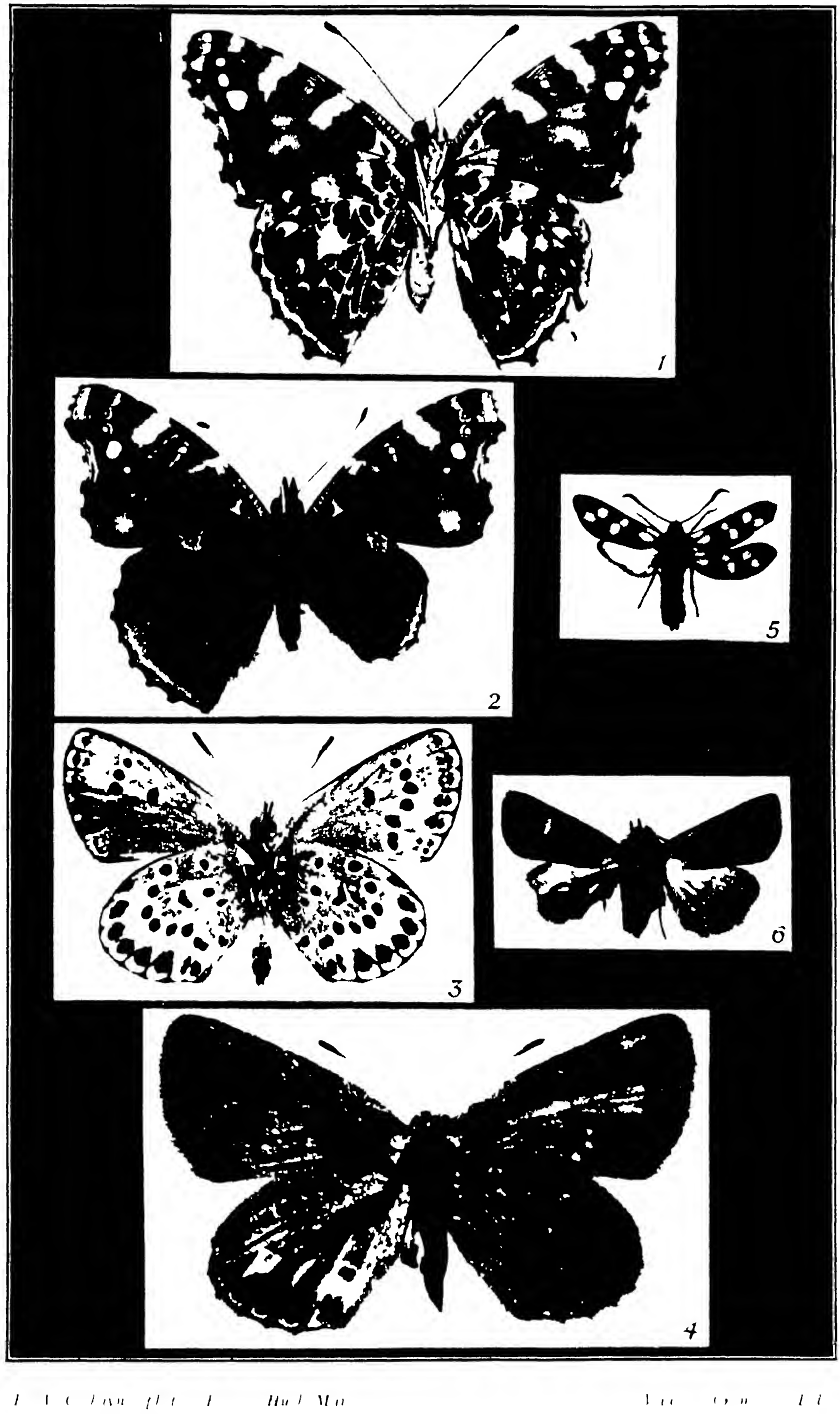


HOMOEOSIS IN INSECTS.

ON THE IDENTITY OF CERTAIN HESPERIIDAE (LEP.) DESCRIBED BY LATREILLE

By N. D. Riley.

[Read March 17th, 1926.]

The names here dealt with are those applied by Latreille (*Encyclopédie Méthodique*, ix, pp. 711–793, 1824) to certain species of Hesperiidae which appeared to him not to be named. Their authorship, in view of the statements in the preface to vol. ix, and on p. 762, has sometimes been attributed to Godart, but it is clear from the footnote on p. 706 that Latreille was the actual author of that part dealing with the Hesperiidae, except for the European species. Unfortunately many of the type specimens involved are not now in the Paris Museum—possibly they never were there at all—but through the kindness of M. F. le Cerf, and with his assistance, I have recently been able to examine those that are still to be found there. The following notes are based on the type specimens unless it is expressly stated that the type is missing. A reference is given to at least one figure of each species when such exists. The numbers prefixed to the species are those of Latreille in *Enc. Meth.* The present identification is indicated by heavy (clarendon) type.

2. *Hesperia metophis*, Latr.

Eudamus metophis.

Eudamus metophis, Bois., Spec. Gen. Lep., pl. 13, fig. 5, 1836; Watson, P.Z.S., 1893, p. 20; Godman & Salvin, Biol. Cent. Amer. Rhop., ii, p. 276, 1893; Mabille, Gen. Ins., fasc. 17*a*, p. 21, 1903; nec *E. metophis*, Draudt, in Seitz' Macrolep., v, p. 855.

Type not in Paris Museum. The above references indicate the species that stands as *metophis* in the Paris collection. There is no reason to suppose that this is not the same as *metophis*, Latreille. It is unfortunate that Dr. Draudt (in Seitz) should describe and figure as *metophis* a species more closely allied to *E. ganna*, Möschler. The diffuse outer edge of the narrow white band on the underside of hind-wing is very characteristic.

5. *Hesperia eurycles*, Latr.

Eudamus eurycles.

Eudamus eurycles, Godm. & Salv., Biol. Cent. Am. Rhop., ii, p. 272.
Goniurus eurycles, Snellen, Tijd. v. Ent., xxx, p. 27, pl. 2, fig. 2.

The type is a ♀ with only four subapical spots—a character more frequent in that sex than in males.

9. *Hesperia cleanthus*, Latr.

Pyrrhopygopsis cleanthus.

Pyrrhopygopsis cleanthes, Mabille, Gen. Ins., p. 18, 1903; *cloanthus*, Watson, P.Z.S., 1893, p. 122; *cleanthus*, Seitz, v, pl. 165*d*, 1922.

Type not in Paris Museum. But authentic specimens, and Latreille's original description, indicate as typical those specimens with the three discal hyaline spots on fore-wing very small and with only one such spot in the cell of fore-wing. Watson and also Godman and Salvin correctly recognised this as a Pamphiline genus; it is difficult to understand why Mabille (*Gen. Ins.*, *l. c.*) should have removed it to the Hesperiinae, where it is quite out of place.

17. *Hesperia xanthippe*, Latr.

Sarbia xanthippe.

Sarbia xanthippe and *S. spixii*, Mab., Gen. Ins., p. 12, 1903; Mab. & Boull., Ann. Sci. Nat. Zool., vii, p. 198, 1908.

As pointed out by Mabille and Boullet (*l. c.*) there was no specimen of the species generally passing in collections as *xanthippe* (i.e. *damippe*, Mab.) in Latreille's own collection. *S. xanthippe* proves to be the same species as *S. spixii*, Plötz, from which it differs only in having the yellow area of hindwing divided by a black band running from the inner margin across the discocellulars to vein 8.

18. *Hesperia versicolor*, Latr.

Mimoniades versicolor, Latr.

Mimoniades mulcifer, Hübn., Zutr. Ex. Schmett. figs. 413, 414, 1825.
M. versicolor, Mab. & Boull., Ann. Sci. Nat. Zool., (9) vii, p. 202.

Mulcifer only differs from the typical form in the absence of the white costal spot immediately above the red transverse median band.

20. *Hesperia iphinous*, Latr.

Phocides iphinous.

Phocides iphinous, Mabille, Bull. ent. soc. France, 1909, p. 334.

Mabille clearly shows that Latreille's *iphinous* is a *Phocides*. The type is missing. The species must be extremely close to Mabille's own *Ph. maximus* (*Le Naturaliste*, p. 77, 1888).

The species Mabille describes at the same time in the above note as *Mimoniades mimetes*, also confused with *M. ocyalus*, Hubn., is the *Hesperia othello* of Plötz (*Stett. ent. Zeit.*, 1879, p. 522).

21. *Hesperia polyzona*, Latr.

Jemadia polyzona.

Pyrrhopyga zimra, Hew., Ex. Butt., iv, *Pyrrh.* ii, fig. 11, 1871.
Pyrrhopyge jamina, Butler, Trans. Ent. Soc. London, p. 499, 1870.
Jemadia zimra and *polyzona*, Mab. & Boull., Ann. Sci. Nat. Zool., Paris, (9) vii, p. 196.

Type missing. Mabille and Boullet (*l. c.*) must be followed; and there can be no question but that they are right. The only misfortune is that they have treated *zimra*, Hew., as being a distinct species and have attached the name to the Paraguayan race, whereas Hewitson's type of *zimra* is absolutely identical in every respect with Butler's type of *jamina*, and therefore both names fall as absolute synonyms of *polyzona*, Latr.

24. *Hesperia santhilarius*, Latr.

Myscelus santhilarius.

M. st. hilarius, Herr.-Sch., Prod. Syst. Lep., p. 59, 1869.
M. santhilarius, Mab. & Boull., Ann. Sci. Nat. Zool., (9) vii, p. 206.

Type not in Paris Museum. Seitz's figure (*Gross. Schmett*, v, pl. 164*g*) of *M. santhilarius* does not represent that species at all; it is a very obvious *M. epimachia*, H.-S. The species he figures (pl. 165*a*, *l. c.*) as *M. epimachia* is not *epimachia* either. It is readily distinguishable from that species by its

prominent black veins on both wings above; by the divergence anteriorly of the two black bands of the underside of the hind-wing; and by possessing, as a rule, a sub-basal translucent spot on the hind-wing.*

25. *Hesperia eacus*, Latr.

Coladenia dan.

Coladenia dan, Piepers & Snell., Rhop. Java, Hesp., p. 3, pl. v, fig. 3.
C. dan eacus, Fruhst., Iris, 1910, p. 67.

Type missing.

28. *Hesperia cramer*, Latr.

Dyscophellus sebaldus.

Papilio sebaldus, Cramer, Pap. Ex., iv, p. 101, pl. 342 A, B.
Dyscophellus sebaldus, Godm. & Salv., Biol. Cent. Am. Rhop., ii, p. 319.

Latreille states that this species was not known to him except from Cramer's figure. I have not seen anything to agree with it. According to Cramer the species comes from Surinam. Specimens agreeing with the figure in the number and position of the transparent markings and in general coloration are in the B.M. from the Amazons, but none of these bears the bluish hind-wing markings shown in Cramer's figure of the underside; they occur, however, in *D. porcius*, Feld. In the absence of material from Surinam it is impossible to say whether Cramer's specimen represents an individual variation or a local race distinct from that which usually passes in collections as typical *sebaldus*.

35. *Hesperia savigny*, Latr.

Acolastus amyntas.

Papilio amyntas, Fab., Syst. Ent., p. 533, 1775.
Acolastus amyntas, Draudt, in Seitz' Macrolep., v, p. 862, pl. 166*g*.

36. *Hesperia schoenherr*, Latr.

Hasora schoenherri.

Hasora schönherr, Fruhst., Iris, 1911, p. 75.

* This species may be described as :—

Myscelus draudti sp.n.

Upperside, both wings rich reddish fuscous, shaded with black, the veins entirely black. *Fore-wing.*—Median hyaline band large (much as in *belti*, G. & S., or *epimachia*), outlined with black, especially distally; the two hyaline spots between the median band and the three subapical hyaline spots linked as a rule to the latter by a single minute hyaline spot in area 5, and shaped as usual in the genus; distal portion of wing much suffused with blackish, especially along the distal edge of the hyaline spots; cilia black. *Hind-wing* markedly oblong in shape; the inner margin heavily clothed with long, black hair scales slightly intermixed with yellow and shading to rufous over the wing surface; a single prominent transverse diffuse black band; basal area, as far as the hyaline spot (when present), black or marked with black; cilia marked with pale yellowish white. *Underside, fore-wing.*—Dark fuscous; the hyaline spots as above; base to just beyond origin of vein 2, and along costa to just beyond hyaline spot in cell, pale yellow; a light grey diffuse band from apex to inner margin just beyond hyaline spots. *Hind-wing.*—Pale yellow; a narrow basal bar, a second wider bar from about centre of costa across to vein 1*b* before the centre, a third from vein 7 towards anal angle, expanding and converging towards the second, the two together filling area 1*b*; a wide marginal band; all black.

Type: 1 ♂, Chairo, Bolivia (*C. Buckley*), B.M.

Paratypes: 1 ♂, Bolivia; 3 ♂s, "Chiriqui"—probably Bolivia (Crowley Coll.); 2 ♂s, Peru; all in B.M.

This species I have always found confused in collections with true *epimachia*.

Parata chuza, Swinhoe, Lep. Ind., ix, p. 257, pl. 753 ♂ [*nec* ♀].
Goniloba derma, Moore, Cat. Lep. E.I.C., p. 245, 1857.

Type missing.

42. *Hesperia polygius*, Latr.

Bungalotis polygius.

Bungalotis polygius, Mab. & Boull., Ann. Sci. Nat. Zool., (9) xvi, p. 135, pl. ii, figs. 5, 6, 1912.

Type missing.

47. *Hesperia antoninus*, Latr.

Thracides antoninus.

Thracides longirostris, Sepp, Sur. Vlind., i, pl. 27, 1848.

Several species are generally confused under the name *longirostris*. For the present the name *antoninus* should be restricted to the larger form with the "reddish-brown" distal portion to the underside of the hind-wing, *telegonus*, Esper (1778), applying to the similar, but smaller form with the relatively large pale spot on hind-wing underside in area 4 covered with frosty white scales, not scaleless. *Longirostris* is best retained for the form with distal portion of hind-wing below shading off into greenish or buff, never violaceous or red. (See *Th. fischeri*.)

Type missing.

[47]. *Hesperia nyctelius*, Latr.

Prenes nyctelius.

Mabille (*Gen. Ins.*, p. 145) treats *nyctelius* as synonymous with *P. nero*, Fab. I cannot agree with this, as by no stretch of the imagination can Latreille's description be made to fit *nero*. The description fits best the species generally known as *ares*, Feld., but I hesitate to identify it with that.

Type missing.

48. *Hesperia dalman*, Latr.

Thespeius dalmani.

Thespeius dalmani, Godm. & Salv., Biol. Cent. Am. Rhop., ii, p. 520, pl. xcvi, figs. 37–40.

49. *Hesperia basoches*, Latr.

Carystoides basoches.

Carystoides basochesi, Godm. & Salv., *op. cit.*, p. 611, pl. civ, figs. 8–11.

Type missing.

50. *Hesperia fischer*, Latr.

Thracides fischeri.

Readily recognisable by its soft green underside coloration and black upperside ground-colour. The translucent spots are quite colourless, not tinged with yellowish; that in the fore-wing cell small, not reaching the anterior cell-margin, square or subquadrate—much as in *Th. salius* (Cram.), Godm. & Salv. The Amazon Valley race differs slightly in having the transparent cell-spot doubled by the addition of a spot anteriorly; in being slightly larger and browner, and in being rather paler green below; but should not be confused with the other similar but much larger species which also occurs

there. This has a fore-wing length of 27 mm. as against 20 mm. in *fischeri*; has all the translucent spots decidedly yellow, with that in the cell comma-like as in *antoninus*; is brown above, not black; and has the green below very definitely purplish-suffused in the ♂, less so in the ♀. The genitalia are quite distinct from those of *fischeri*. This new species may be known as **Thracides hewitsoni**, sp. nov., the types ♂ ♀ from the Hewitson collection being in the B.M. The ♂ type bears the label "Nauta, Upper Amazons"; the ♀ bears no data, but probably comes from the same locality. A variety of the male in which the green underside coloration is entirely replaced by purplish is figured (as *Th. longirostris* var.) by Godman and Salvin, *Biol. Cent. Am. Rhop.*, pl. 106, fig. 9. *Th. fischeri* is closely allied to *Th. longirostris*.

Type missing.

51. *Hesperia lesueur*, Latr.

Thracides lesueuri.

Thracides lesueuri, Mab., Gen. Ins., Hesp., p. 179.
Hesperia caesena, Hew., Ex. Butt., iv, *Hesp.* pl. 2, figs. 17, 18.

Type missing. One can only accept Mabille's determination. Latreille's description fits some specimens of *caesena*, Hew., quite well; but it also fits many other species equally well. The figure in Seitz (v, pl. 191) seems to be a poor reproduction of Hewitson's figure.

52. *Hesperia bonfilius*, Latr.

Vacerra bonfilius.

Hesperia litana, Hew., Trans. Ent. Soc. London, p. 494, 1866: Ex. Butt., v, *Hesperia*, pl. v, figs. 42, 43 (♀).
Goniloba caprotina, H.-S., Prod. Syst. Lep., iii, p. 71.
Hesperia aeas, Plotz, Stett. Ent. Zeit., xliii, p. 439.
Hesperia socles, Plotz, *t. c.*, p. 438.
Hesperia archytas, Prittw. MS.
Vacerra bonfilsii and *litana*, Mab., Gen. Ins., Hesp., p. 148.

Type missing. According to Mabille, Hewitson's figure of *litana* represents a typical *bonfilius*. His figure, however, is a poor illustration of his type and does not accurately agree with his description: "fore-wing with *nine* transparent spots," etc. The position appears to be that *bonfilius*, *caprotina* and *archytas* all refer to the S.E. Brazilian race in which the cell-spot and the spot in area 2 form a well-marked band, and the spot in area 3 is nearly always absent, those in areas 4 and 5 always so. The Amazonian-Guianan-Venezuelan race, which is readily distinguished by the possession invariably of transparent spots in areas 3 and 4 of the fore-wing in the ♂, and in area 5 as well (sometimes double) in the ♀, is typical *litana*; *socles*, Plötz, also refers to this race. The C. American race, characterised by having a well-defined transparent spot in area 3, but (apparently) never any in areas 4 and 5, has been named *aeas* by Plötz.

67. *Hesperia lucretius*, Latr.

Carystus lucretius.

Carystus lucretius, Mabille, Gen. Ins., Hesp., p. 160.

Type missing. No figure of this species appears to be published. Latreille's description is quite good. The expanse of wing is 30–35 mm., the upperside

slightly shiny dark brown. The fore-wing bears three punctiform yellowish subapical spots as a rule, not in an absolutely straight line, a small quadrate yellow spot towards base of area 3, a similar, much larger spot towards base of area 2, a third oblong rectangular yellow spot on vein 1 about the middle, and a diffuse yellow streak below this in 1*a*. The hind-wing bears a transverse yellow band from vein 1*b* to vein 6, of variable width, frequently broken up by the veins into separate spots, never with sharply-defined edges, and cut in two by a long sharp-pointed projection of the ground-colour from the base along vein 4. The markings of fore-wing are repeated below, but are paler, and in addition the apical area, the inner margin and a short basal streak are grey with numerous short transverse striae; the yellow band of upperside is white. A large suboval black spot occupies the base of area 8; a much smaller intensely black circular spot is situated in area 1*c* on and midway along vein 2; the base of area 2 and a contiguous larger area in area 1*c* are also black, the triangular black mark so formed forming part of the lower edge of the large triangular dark area, diffuse basad (represented above by the projection which cuts the transverse yellow band), one angle of which is on the costa rather beyond the middle of vein 8, one on vein 4 nearly at the margin, and the third would be on inner margin about one-third from base were it not cut off by the grey abdominal area. Hind margin grey, the same colour as interior of the large triangular area.

68. *Hesperia lafrenaye*, Latr.

Vettius lafrenayei.

Vettius lafresnayi, Godm. & Salv., Biol. Cent. Amer. Rhop., ii, p. 590, pl. 102, figs. 30, 32

Type missing. The description given by Latreille fits exactly the S. Brazilian form of the species. This differs from the form figured by Godman and Salvin in several important particulars. It is a good deal larger, the ♂ fore-wing being about 18–19 mm. long as compared with 16–17 mm. in the form figured; the fore-wing cell has always two hyaline spots, not one only; and the dark markings of hind-wing and of apex and costa of fore-wing on the underside are very decidedly rusty-red in colour. The form figured by Godman and Salvin would appear to be the typical British Guiana race with only one hyaline spot in all and a dusky brown underside.

76. *Hesperia seneca*, Latr.

Orses seneca.

Hesperia crotona, Hew., Trans. Ent. Soc. London, 1866, p. 493.
Hesperia elisa, Plötz, Stett. Ent. Zeit., xliii, p. 328, 1882.
Orses crotona, Mab., Gen. Ins., Hesp., p. 178.

Type missing. There can be no doubt that Latreille's description refers to the white-banded female of this species, which Hewitson also described. Plötz described the ♂. With the exception of some slight confusion which seems to have crept into Latreille's reference to the number of the dark red-brown spots of the underside, his description fits the species perfectly. He mentions *one* on the costa of the fore-wing, and then states there are *five* on each lower wing. However, he describes *two* on the lower wing and then *the other two* on the same wing. Actually there are only these four, unless one calls the darkened distal portion of the abdominal area the fifth.

77. *Hesperia claudianus*, Latr.

Carystus claudianus.

Carystus claudianus, Godm. & Salv., Biol. Cent. Amer. Rhop., ii, p. 583, pl. 102, figs. 1–4.

78. *Hesperia minos*, Latr.

Zenis minos.

Zenis minos, Godm. & Salv., Biol. Cent. Amer. Rhop., ii, p. 589, pl. 102, figs. 24–27.

Typical *minos* from Brazil has the posterior portion of the cilia of both wings very white, and the veins of the underside finely marked with yellowish. In the race *jebus*, Plötz, the cilia are sometimes pale, but never so abruptly white, and the veins below, at least on the hind-wing, are not marked with yellow. *Jebus* seems to be the northern race, extending from N. Brazil to Mexico. *Melaleuca*, Plötz (*Stett. Ent. Zeit.*, xliii, p. 443, 1882), is a good species. It is always rather larger than *minos*, and has, as a rule, only three transparent spots in the subapical series, unevenly arranged, there being no spot in area 9.

80. *Hesperia dumeril*, Latr.

Paradros dumerili.

Eudamus formosus, Feld., Reis. Nov. Rhop., p. 511, pl. 71, figs. 6 & 7.
Paradros formosus, Godm. & Salv., Biol. Cent. Amer. Rhop., ii, p. 348.

As pointed out by Godman and Salvin, *P. formosus* is not the same as *P. oriander*, Hew., which can be distinguished at once by the characters they give. *P. oriander*, Hew., has been recently redescribed by Mabille and Boullet as *P. ploetzi*, according to specimens so labelled in the Paris Museum, but I have been unable to discover any published description.

89. *Hesperia justinianus*, Latr.

Phanis justinianus.

Phanis justinianus, Godm. & Salv., Biol. Cent. Amer. Rhop., ii, p. 549, pl. 99, figs. 24–27.

Type missing.

91. *Hesperia menestries*, Latr.

Paracarystus menestriesi.

H. menestriesi and *H. rona*, Hew., regarded by Godman and Salvin as one and the same species (*Biol. Cent. Amer. Rhop.*, ii, p. 587) may well be distinct. *Rona* is consistently smaller than *menestriesi* and always has two hyaline spots in fore-wing cell; these are absent in *menestriesi*. *Rona* occurs from the Amazon valley to Colombia; *menestriesi* only in S.E. Brazil. They may prove to be races. Butler's *koza* (*Trans. Ent. Soc. London*, p. 507, 1870) is most probably only an aberration of *rona* with the outer transverse brown band of underside of hind-wing obsolete.

98. *Hesperia godart*, Latr.

Lycas godarti.

Hesperia ceraca, Hew., Ex. Butt., v, *Hesperia*, pl. 5, figs. 42, 43, 1872.

Hewitson's type of *ceraca* is a ♀, and agrees perfectly with Godart's ♂ type.

99. *Hesperia julianus*, Latr.

Parnara mathias, Fab.

P. matthias, Piepers & Snell., Rhop. Java., Hesperidae, p. 35, pl. 8, fig. 50, 1910.

The type is not in the Paris Museum. There can be no doubt, however, that *julianus* is synonymous with *matthias*. Swinhoe (*Lep. Indica*, x, p. 320) holds the same view.

100. *Hesperia peron*, Latr.

Toxidia peroni.

T. peroni, Waterhouse & Lyell, Butt. Australia, p. 190, 1914.

103. *Hesperia silius*, Latr.

Cymaenes silius.

Cymaenes silius, Godm. & Salv.. Biol. Cent. Amer. Rhop., ii, p. 596, pl. 103, figs. 4–6

Godman and Salvin figure the Mexican form, which seems also to occur throughout Central America, and is characterised by a wider and more definite pale fascia on the fore-wing above than is present in typical S. Brazilian *silius*, and by a more ochreous underside. Typical *silius* is a dark insect with the fore-wing fascia rather greenish ochreous, little paler than the ground-colour and parallel-sided. Beneath, the hind-wing is also very dark, speckled with pale, rather greenish grey. Northwards the species gets brighter, and *antistia*, Plötz (*Stett. Ent. Zeit.*, xliii, p. 320), seems very well to fit specimens from Bahia, Pernambuco, etc., whilst the form occurring in Colombia to Guiana has already been named *pericles*, Möschler (*Verh. zool. Ges. Wien*, p. 218, 1878), and is by far the brightest race. The E. Cuban race (Tagua and Rio Caño) is peculiarly dark, especially below, on which surface it is remarkable for the strong admixture of purple scales in the distal half of hind-wing. It may be known as **C. silius schausii** ssp. nov., the types ♂ and ♀ being in the B.M.

Type missing.

104. *Hesperia cornelius*, Latr.

Euphyes cornelius.

Goniloba cornelius, Gundlach, Ent. Cub., i, p. 167, 1881.
Goniloba hemelerius, H.-S., Prod. Syst. Lep., iii, p. 76, 1869.

Specimens are in the B.M. compared with Herrich-Schaeffer's type of *G. hemelerius*. Latreille's and Gundlach's descriptions are both very good. The males are frequently entirely devoid of pale spots above; if such spots are present they never exceed two in number it would seem; one towards base of area 3, the other towards base of area 6. The female has an additional spot in 7 and a large one towards base of area 2, and shows the same bronze reflections on the fore-wing as the ♂. Occurs in Cuba and also in the Bahamas.

Type missing.

105. *Hesperia pompeius*, Latr.

Hedone athenion.

Type missing. The only species to which the description seems in any way applicable would appear to be that known as *Hedone athenion*, Hübner, a common species throughout tropical America, and well figured by Hübner

in *Samml. Ex. Schmett*, ii, pl. 148. Information as to the exact date of publication of Hübner's plate is not available; it may have been later than 1824 (the date of publication of *H. pompeius*, Latr.), but it is more probable that it was earlier. Under the circumstances *pompeius*, hitherto unrecognised, should be treated as a synonym, and *athenion* stand.

106. *Hesperia mesogramma*, Latr.

Atalopedes mesogramma.

Hesperia alameda, Lucas, in Sagra Hist. phys. Cuba, p. 649, 1856.
Hesperia cunaxa, Hew., Trans. Ent. Soc. London, (3) ii, 1866, p. 488.
Pamphila alameda, Gundlach, Ent. Cub., i, p. 148, 1881.

Gundlach was wrong in supposing *mesogramma* not to be the same as *cunaxa*. The type is in the Paris Museum.

110. *Hesperia drury*, Latr.

Catia otho.

Pap. otho, Smith & Abbot, Lep. Ins. Georgia, i, p. 31, pl. 16, 1797.
Hesperia aetna, Bois., Ind. Meth., p. 35, 1840.
Thymelicus aetna, Scudder, Butt. New Eng., p. 1696.

Type missing.

114. *Hesperia flavovittata*, Latr.

Padraona flavovittata.

P. flavovittata, Waterh. & Lyell, Butt. Australia, p. 203, 1914.

The sole remaining specimen in the Paris Museum bearing a label "*flavovittata*"- and considered to be the type—is a ♂ *Taractrocera papyria papyria*, Bois. However, I have no hesitation in rejecting this specimen as not being the true type. Latreille's description is obviously based on more than one specimen. The greater part of the description refers to true *flavovittata*, but at the end he adds " Les bandes jaunes *quelquefois* ne forment que des lignes, et celle de l'extremité posterieure des premières ailes est partagé en deux." This is the only portion which can, and in fact obviously does refer to *papyria* rather than to *flavovittata*, and I think it may safely be inferred that he had both species in his original series. If further evidence were wanted it is to be found on p. 161 and p. 162 of the *Voyage de l'Astrolabe*, 1832. Here Boisduval repeats Latreille's description of *flavovittata* and adds his own description of *papyria*; of the latter he says " les inferieurs avec . . . une bande blanche " on the underside. It is surely inconceivable that Boisduval, who had access to Latreille's type, who, in fact, lived almost within a stone's throw of the national collection, could have redescribed Latreille's species. I fully agree with the opinion expressed by Waterhouse and Lyell.

115. *Hesperia themistocles*, Latr.

Polites themistocles.

Papilio taumas, Fab., Mant. Ins., ii, p. 84, 1787.
Hesperia phocion, Fab., Ent. Syst., Suppl., p. 431, 1798.
Polites taumas, Lindsey, Iowa Studies Nat. Hist., ix, 2, 4, p. 80, 1921.
Limochores taumas, Scudder, Butt. New. Eng., pl. 10, figs. 17 & 21.
Polites themistocles, Barnes & Benjamin, Ent. News, xxxvii, p. 269, 1926.

Latreille himself says this is the *Hesperia phocion* of Fabricius, and that he has not seen the species.

133. *Hesperia hottentota*, Latr.

Gegenes hottentota.

Pamphila obumbrata, Trimen, P.Z.S., 1891, p. 103, pl. ix, fig. 23.

Latreille's description clearly refers to a *Gegenes*, but not definitely to any particular species. The type specimen, however, belongs undoubtedly to the species described as *obumbrata* by Trimen, which differs from *lettersledti* in many important morphological features.

134. *Hesperia lepeletier*, Latr.

Leptalina lepeletieri.

Cyclopides lepeletierii, Trim., S. Afr. Butt., iii, p. 274.

Type missing. There is no possibility of mistaking the species.

135. *Hesperia l'herminier*, Latr.

Lerodea l'herminieri.

Hesperia fusca, Grote & Robinson, Trans. Am. Ent. Soc., i, p. 2, 1869.
Megistias fusca, Barnes & McDun, Check List, p. 22, 1917.
Lerodea fusca, Skinner & Williams, Trans. Am. Ent. Soc., xlix, p. 143, 1923.

The only other species to which this name might apply are *Amblyscirtes alternata*, Grote and Rob. (*eos*, Edw.), which is occasionally devoid of transparent spots, or, as suggested to me by Dr. Skinner, *Lerodea neamathla*, Skinner and Williams (*l. c.*, p. 145). Both these species, however, seem to be much rarer than *fusca* of Grote and Robinson, and, as *fusca* agrees very well as to characters and localities with Godart's *l'herminier*, I think there is sufficient justification for the synonymy given above.

Type missing.

143. *Hesperia orbifera*, Godt.

Hesperia orbifer.

Pap. orbifer, Hübn., Samml. Eur. Schmett, i, pl. 161, 1823.

147. *Hesperia cardui*, Godt.

Hesperia malvae.

Pap. malvae, Linn., Syst. Nat. Ed. x, p. 485, 1758.

157 (note). *Hesperia nigrita*, Latr.

Kerana nigrita.

Nisoniades diocles, Moore, Proc. Zool. Soc. Lond., 1865, p. 787.
Kerana diocles, Dist., Rhop. Malay, p. 403, pl. 34, fig. 8, 1886.
Tamela diocles, Swinhoe, Lep. Ind., x, p. 207, pl. 805, fig. 2, 1913.
Tagiades fumatus, Mab., Bull. soc. ent. France, p. xxvi, 1876.

Mabille suggests (*Gen. Ins.*, *Hesp.*, p. 175) that his *fumatus* is *Stimula swinhoei*, Elwes. *Fumatus*, however, was described from the Philippines, and the description does not fit *swinhoei* in the least.

164. *Hesperia chlorocephala*, Latr.

Staphylus chlorocephala.

According to the arrangement in the Paris Museum this species is the same as *Bolla cupreiceps*, Mabille. The latter, however, has the head and palpi

golden-coppery, with no trace of green and not in any way glistening, which cannot be made to agree with Latreille's " palpis capitisque vertice squamis *viridibus, micantibus*." *Chlorocephala* therefore cannot refer to that species. Godman and Salvin applied the name to the species described in 1877 by Mabille as *cupreus* (*Bolla cupreus*, Mab., *Gen. Ins. Hesp.*, p. 72, 1903). But Mabille's *cupreus* has a large golden-green glistening area at the base of all four wings, and it is impossible to suppose that Latreille would have failed to mention such a character had it existed in the species he was describing. *Gorgopas viridiceps*, Butler, agrees as to the colour of head and palpi, but is a fairly large insect, has three conspicuous subapical spots, and has no paler area towards underside of hind-wing.

There is, however, a single ♂ of a species from Minas Geraes in the B.M. which agrees exactly with Latreille's description. The length of the fore-wing is 14 mm. It is very dark brown above with two barely indicated macular transverse bands across both wings, the inner one on fore-wing straight, the outer broken at veins 3 and 7, on the hind-wing both angled equally about midway and not so macular; the margins also broadly darker. Both wings speckled with grey scales. Upper surfaces of head, collar and palpi brilliant glistening golden green. The underside of wings paler than above, the fore-wing with only the barest indication of the upperside bands; the hind-wing the same in costal area, but the ground-colour between this area and anal angle becomes gradually more and more intensely suffused with pale greyish, against which the markings of the upperside are represented by diffuse macular fuscous bands, until at anal angle and along the abdominal margin it is entirely grey. The outline of the wings is almost exactly that of *S. ascalaphus* as figured by Godman and Salvin in *Biol. Cent. Amer. Rhop.*, iii, pl. 89, figs. 12 and 13. There are no hyaline spots. The species is comparatively well represented in Plötz' unpublished drawings, plate 1056.

Type missing.

167. *Hesperia westermann*, Latr.

Systasea erosus.

Urbanus vetus erosus, Hübn., S. Exot. Schmett, i, pl. 153.

Type missing.

171. *Hesperia brebisson*, Latr.

Gindanes brebisson.

Pterygospidea phagesia, Hew., Desc. Hesp., p. 54, 1868; Ex. Butt., v, *Pteryg.*, pl. i, fig. 5, 1873.

Brit. Mus. (N.H.),
S. Kensington.

INSECT VISITORS TO SAP-EXUDATIONS OF TREES

By G. Fox Wilson, N.D.Hort.

[Read February 3rd, 1926]

Plates LXV–LXVII and One Text-figure.

General Review.

Sap-exudations or slime fluxes of trees are of four kinds, viz. (1) black, (2) brown, (3) red, and (4) white. It is not intended in this paper to review these phenomena from any other standpoint than that of their attractiveness to certain insects.

The term "slime flux" is not a happy one, on account of a somewhat similar term being applied to the *Mycetozoa*. It is preferable to refer to it as "mucilaginous exudation" or the "weeping" of trees (Ogilvie, 14), or, as Ludwig (7, 8) called it as long ago as 1886, "alcoholic flux" and "white slime flux." Ogilvie (14) describes the micrococcal and fungal flora in various fluxes, and found that there were marked differences between the constituents of the material he examined and those described by continental workers; from this he concluded that yeasts and fungi are not the causative agents.

Ludwig (9) said that the result of white slime or alcoholic flux in oaks and other trees is a complete fermentation of the bark, bast and cambium and sometimes a part of the wood. Marshall Ward (10) observes that the trunks of various trees may sometimes pour out a slimy fluid from cracks in the bark, old wounds and branch scars.

Our observations will be confined to the white fluxes, which occur on many forest trees, especially ash, beech, birch, maple, oak, poplar and willow.

The tree under consideration is an oak growing in the Wild Garden of the Royal Horticultural Society's Gardens at Wisley, Surrey (Plate LXV). There are other oaks growing in the same wood, but none of them have shown any sign of exuding sap. The dimensions of the affected tree are as follows :—the height is 55 feet, and the stem, which to a height of 17 feet is devoid of branches, bears 77 excrescences or burrs, out of which exudes the fermented sap. Irregular excrescences, from which spring a complex nest of adventitious buds, are not uncommon phenomena on many trees, notably elm, maple and oak. Only two excrescences occur above where the branches commence. The circumference at 18 inches above ground-level measured over the largest swelling 71 inches. The circumference at 3 feet high is 60 inches, and taken at the same height over a burr is 63 inches. The size of the excrescences varies from 2 to 14 inches in diameter (Plate LXVI) and from 1 to 4 inches in depth. They are circular except when one or more of them run together to form a large oval mass.

Causes of "Weeping" in Trees.

There are many theories as to the cause of sap-exudations. Ludwig (9) found that their presence was associated with branch scars, frost cracks, borings of *Cossus* and other insects, and that they also sprang from uninjured bark. The tree at Wisley falls into the last category; it appears to be perfectly healthy, apart from some slight disintegration of the bark, and has been known

to exude for several years, although close observations on the insect visitors were not commenced until the summer of 1921.

Miller Christy and Nicholson (12) suggest that, in the case of elm, "bleeding" may be due to any one of the following causes :—pruning branches and twigs during the growing season; high winds causing either an internal or an external splitting and allowing sap to escape; and the liability of *Ulmus* species to shed their branches.

Marshall Ward (10) says that this phenomenon is due to large quantities of sap being under considerable pressure from the roots, and is, primarily, a normal occurrence comparable to the "bleeding" of lopped trees in spring. In some cases, lightning may cause the wound.

Ogilvie (14) considers that white fluxes originate in the bark and are always associated with wounds or an unhealthy state of the tree. This worker obtained negative results from inoculation experiments, which appears to point to the fact that fluxes are of physiological origin. Massee (11), on the other hand, regards the occurrence of slime flux of plum trees as a disease, access being gained through wounds (branch scars, broken branches and eroded bark) and insect punctures. He also suggests that the spores are readily dispersed by wind, rain, field implements, and field mice and other rodents, whilst Ludwig attributes the dispersal of the flux to hornets, wasps, bees, flies and stagbeetles.

Length of the Periodic Flow.

Our remarks will be confined to the white fluxes, as the other varieties differ from them both in the length of time that the flow continues and in the micrococcal and fungal flora present.

The flow continued from the third week in June to the last week in September, and was constant over a period of five years (1921–1925). In the latter part of June the flow is fairly regular but is not abundant. During July and August the flow is plentiful and in some years is so copious that it runs down the trunk, sometimes to a distance of ten inches below the excrescence, causing the bark to become blackened (Plate LXVII). The greatest flow occurred in the third week in July 1924, prior to a deluge of rain which fell on the 22nd, when 4·7 inches of rain fell in an hour and a half. This heavy rainstorm washed away all traces of flux, which, however, recommenced on the 25th.

Ludwig (9), Holtz (3), Joy (5) and Ogilvie (14), among other recorders of slime fluxes on oaks, agree that the flow continues over a comparatively short period, ranging from four to five months.

Position on Tree.

The exudations occurred only on the main trunk and proceeded from excrescences on the bark, most of which were situated towards the base of the tree. From all the excrescences there was an exudation, but more particularly from those situated between 4½ and 12 feet above the ground-level.

Composition of the Flux.

The sap of most trees contains varying quantities of sugar, which easily ferments and produces, in company with various yeasts, alcoholic products. Some member of an homologous series of alcohols was present, but the very small quantity of flux obtained did not permit the determination of the boiling point.

In August 1924 portions of the frothy exudations were obtained and chemically examined. A non-reducing sugar, probably cane-sugar, was

present together with a reducing sugar which, provided that the original sugar was cane-sugar, would be glucose (dextrose) or laevulose (maltose).

There was a decidedly acid reaction with litmus and methyl red. Readings for p^{H} were taken by means of Allen and Hanbury's Tabloid Indicators and not electrometrically. The p^{H} reading was 4·5, which showed that the white slime flux of oaks is distinctly acid and more so than the brown and red varieties.

The insoluble portion of the flux consisted of cellulose. No data were obtained as to the micrococcal and fungal organisms present.

Chemotropic Responses of Insects to Flux.

The yeasts and fungi present cause fermentation, to which the distinct odour of beer and the frothiness is due. There is a striking resemblance to the odour of Carolina Allspice flowers (*Calycanthus floridus*). The peculiar odour of these flowers is due to an Indoloid scent, which belongs to those volatile substances that arise from the decomposition of albuminous compounds and diffuse into the atmosphere.

This fermented sap proved to be a source of great attraction to many insects, and as beer has marked chemotropic properties for certain Diptera, it followed that the largest number of insects belonged to this Order.

Chemotropism is the response to chemical stimuli, and may be either (i) positive—definite attraction, or (ii) negative—definite repulsion. The olfactory organs of insects are stimulated by the presence of the flux, which may be their actual food or resemble it in odour and appearance. Trägårdh (16) has pointed out that, from an economic standpoint, there is a promising field of research in the reaction of insects to various chemical substances. The most successful chemotropic agents are those which attract the gravid females rather than the males. Cuscianna (2) has carried out some exhaustive experiments on the chemotropic responses of insects to four groups of odours, viz. aromatic, ethereal, balsamic and nauseous. In the Order Diptera, he found that among the ANTHOMYIIDAE, species of *Anthomyia* and *Hylemyia* were attracted by odours of all the groups tested. In the family MUSCIDAE, *Muscina* is specially attracted to vinegar and nauseous-smelling substances; *Lucilia* favours nauseous odours; and *Calliphora* behaved uniformly towards all the odours tested. It will be seen that these flies were abundant on oak flux at Wisley.

Imms and Husain (4) in similar experiments used, amongst other attractive substances, a 50 per cent. solution of beer and found that it was a powerful chemotropic agent for various Diptera. About forty species were attracted, and of these nine were taken at Wisley on oak flux which possessed a distinct beer-like odour.

Dr. Waterston (18) in his notes says, that " On many occasions during the past twenty years, in localities ranging from Shetland to Salonika, I have noted the attractiveness of various liquids, exposed within doors, for flies—chiefly *Musca* and *Fannia*. The conditions usually were that the liquids were exposed in a test-tube (½–1 inch diameter) standing in a copper bath filled with water, so as to afford an exposed surface thirty or forty times as great as that of the liquid in the tube. Though no deliberate experiment was made, a control was therefore present.

(1) Water itself (unless accidentally spilt in drops) seldom attracts insects except in the hottest weather.

(2) Alcohols at any strength may attract and, if so, speedily destroy flies.

The insects appear to miscalculate the strength of the surface film and fall in at the first contact. Weak solutions of alcohol appear to be more potent than stronger ones, and ethyl alcohols to be the most attractive.

(3) A small addition of glacial acetic acid to any alcoholic solution makes the fluid more attractive.

(4) Most potent of all alcoholic solutions are those to which hydrochloric acid has been added. The ester so set free often has shown the presence of flies in a room where none was suspected.

(5) Solutions of potassium hydrate—up to 15 per cent.—also attract flies and more readily when they have been used previously for boiling up other insects."

Effect of Weather on the Flow.

Graphs have been made showing (i) the temperature of the air, (ii) sunshine, (iii) the percentage of relative humidity and (iv) rainfall over a period of five years (1921–1925). The chief factor which appears to affect the flux flow in the summer months is the amount of rain which falls in the preceding autumn and winter. The graph (Text-fig. 1) gives the monthly rainfall readings together with an additional graph showing the amount of flux flow during the months June to September. The flow was excessive during the years 1923 and 1924, partly due to the excessive rain which fell in the preceding autumns and winters. In 1921, an excessively dry year, and in 1922 and 1925, both with comparatively low rainfalls, the flow of sap-exudations was considerably reduced.

The relative humidity in the atmosphere fluctuates to such a degree from day to day, and even from hour to hour, that a monthly survey of these readings does not show what effect this factor has on the flow.

Height at which Insects are found.

Insects were found to feed on the frothy exudations at every excrescence to a height of 17 feet. Bees and wasps preferred to work at the lower levels, *i.e.* to a height of 8 feet, whereas the Red Admiral butterfly (*Vanessa atalanta*, L.) and Diptera were present at all the sap-exuding centres. Nicholson (13) found neuter *Vespa germanica*, Fab., present on an elm up and down the main trunk to a height of 60 feet.

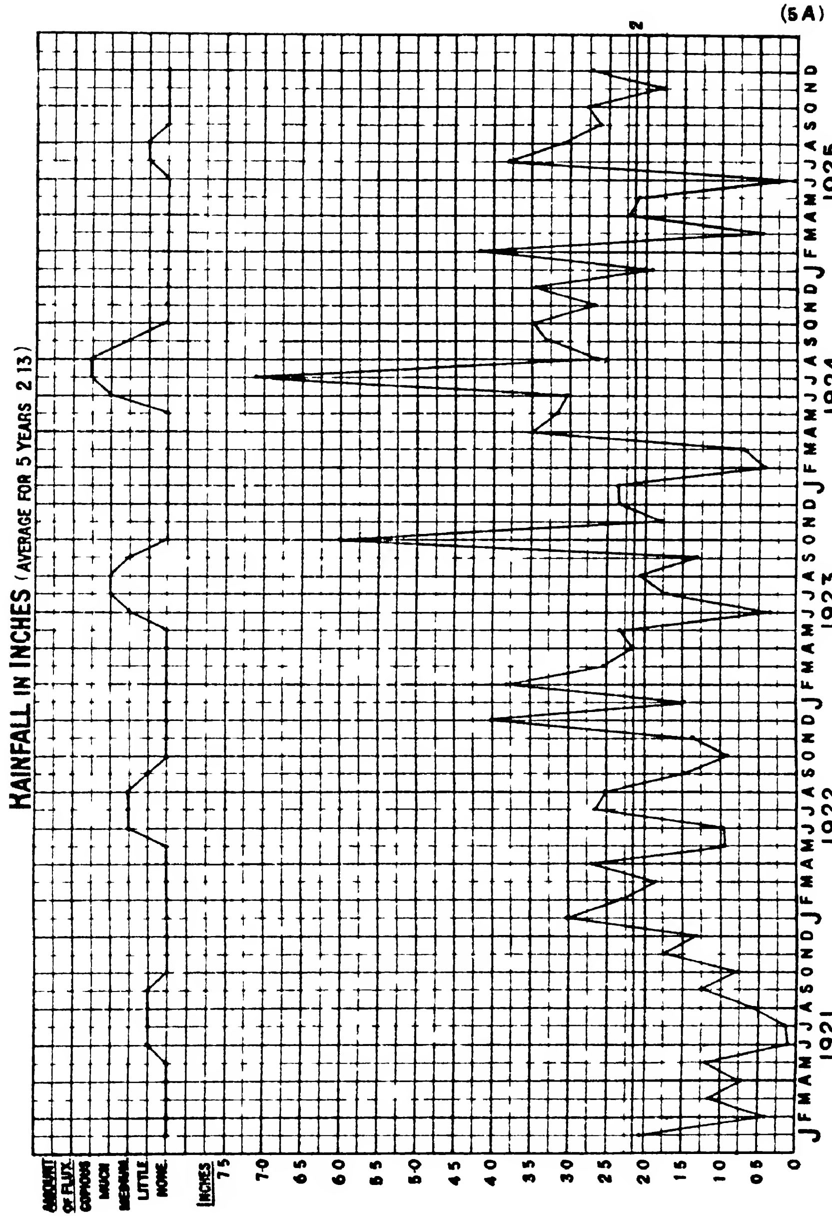
Observations on the Insect Visitors to Flux.

A list of all the species taken at flux during the years 1921–1924 appears at the end of this paper.

The visitors have been tabulated as follows:—

Group I. Species that are specially attracted to the flux—positive chemotropism—many Diptera.
Group II. Species that find the fermented sap palatable—wasps, bees and Lepidoptera.
Group III. Species which are normally found on and under bark—Psocids.
Group IV. Predacious species including—
  (*a*) Those that partake of a mixed diet—Staphylinids.
  (*b*) Those that are attracted by the presence of prey—Carabids.

The majority of the visitors belong to the Order Diptera, other Orders represented being Hymenoptera, Coleoptera, Lepidoptera, Hemiptera and Psocoptera.



TEXT FIG 1 —Graph of the monthly rainfall at Wisley over a period of five years (1921–1925).

There are numerous records in entomological literature dealing with the species of insects taken at flux, and amongst those observers who record their captures at oak flux are Benson (1) (*V. antiopa*, L.); Joy (5) (*V. polychlorus*, L., *Vespa rufa*, L., and several species of Coleoptera); Peachell (15) (*V. atalanta*, L., *V. polychlorus*, L.); and Walker (17) (*Vespa crabro*, L.).

I am indebted to Prof. T. B. Fletcher for drawing my attention to a popular and interesting record of an exuding oak tree in a book *Beautiful Switzerland: Lausanne and its Environs*, by G. Flemwell, pp. 55–56, 1914. The author says: " I know of one old oak tree in the Bois de Plamont (between Cheseaux and Villars St. Croix) which is a remarkable trysting-place for wood- and copse-loving butterflies. This oak finds its struggle for existence tense and not a little unsatisfactory. It is gnarled, broken and bleeding—bleeding with a sort of sticky juice which trickles down the furrows in its bark, and which is evidently seductive nectar to the insects. Many times have I sat and watched this tree for hours, and have seen the Comma and Large Purple Emperor, the Red Admiral and Camberwell Beauty, the Large and Small Tortoiseshell, the azure-suffused White Admiral (*cammila*) and shy Purple Hairstreak, and at least two forms of *Satyrus*, to mention nothing of such moths as the Silver-Y, the Yellow Underwing and the Clifden Nonpareil, and all—except the two latter, who were sleeping off the previous night's orgy—feasting, rapturously oblivious of my near presence."

In dealing with the various Orders, we will consider first the

Hymenoptera.

The most frequently met with were Social Wasps, represented by three species, of which *Vespa germanica*, Fab., and *V. vulgaris*, L., were the commonest. Neuter wasps were daily visitors throughout July and August, whilst in September there were many females. They fed ravenously on the frothy exudations and penetrated far into the interstices of the bark, with the result that large numbers became intoxicated and fell to the ground, where they became the prey of Carabid beetles and ants. The workers would cluster together on the excrescences, where as many as twelve have been counted at one time. If a wasp alighted on an excrescence which was occupied by flies, it became pugnacious and drove them away.

Humble bees were less common, only one species being taken—*Bombus lucorum*, Smith. Several neuters and females would visit the sap on sunny days in 1921 and 1922, but none was seen in the other years.

Hive bees were frequent visitors in most years, except 1923 and 1925. Both the hive and humble bees were seen ravenously feeding on the flux, and in consequence became intoxicated.

Diptera.

Members of this Order were by far the most numerous, both in the number of species and individually. Ten Families were represented including twenty species. In numbers the Anthomyiidae and Muscidae surpassed all others. Many of them penetrated far into the interstices of the bark, but some of the smaller Anthomyiids fed on the flux which had run down the trunk. Atmospheric conditions play a large part in the positive chemotropism of fluxes, but we have been unable to arrive at definite data as to what constitute the most favourable conditions for attracting Diptera. It was observed that the largest numbers of flies were present on dull, calm days when the atmosphere was surcharged with a high percentage of water vapour. Cuscianna (2) found

that calm, windless days with a temperature between 71° and 86° F. were the ideal atmospheric conditions for attracting flies to his baits.

During July and August, large numbers of flies congregated on the excrescences, the dominant species being among the (i) ANTHOMYIIDAE—unidentified Anthomyiids and *Phaonia erratica*, Fall., the latter was the most frequent of all visitors—as many as fifteen were taken at one centre; (ii) MUSCIDAE—*Mesembrina meridiana*, L., *Calliphora erythrocephala*, Mg., *Lucilia caesar*, L., and *Muscina pabulorum*, Fall., all of which were found at the flux from June to September. The other species, with the exception of dung flies (*Scatophaga stercoraria*, L.) and flesh flies (*Sarcophaga carnaria*, L.), were only occasionally met with.

Two species of dipterous larvae, belonging to the Families SYRPHIDAE and DROSOPHILIDAE, were found in the flux, but unfortunately were not bred out. For identifying them, I am indebted to Dr. Keilin of the Molteno Institute for Research in Parasitology, who has made a speciality of the insect fauna of fluxes. The reason that only three larvae were found in oak flux at Wisley may be accounted for by the absence of large masses of material. Unlike the flux on certain trees, the white flux of oaks does not coagulate but is inclined to run down the trunk, and it was only in a deep crevice in the bark that one found a mass of sago-like substance (Plate LXVI).

Dr. Keilin (6) has described the larval and pupal stages of *Dasyhelea obscura*, Winnertz (CERATOPOGONIDAE), taken from decomposed sap filling the wounds of elm trees, and mentions Edward's records concerning the larval habitants of this midge, the running sap of an oak being cited. The author gives a list of seven species of Diptera whose larvae and pupae were found together with those of *D. obscura* in decomposed sap of elm.

LEPIDOPTERA.

The only member of the Rhopalocera found on oak flux was the Red Admiral butterfly (*V. atalanta*, L.), numbers of which abounded on the trees on sunny days and less so in dull weather. On becoming gorged, they could be picked off the trunk with ease.

Heterocera—very few moths were found feeding actually on the flux. The presence of *Drepana binaria*, Hufn., is accounted for by the fact that its larvae feed on oak. Several Tortricids were caught in the viscid masses, but only a few were seen feeding thereon.

It was disappointing to find so few members of this Group attendant on the slime flux, although many species were taken at "sugar" on neighbouring trees. It has been suggested that the artificial bait was more attractive, but this is disproved by the fact that whilst "sugaring" was done on comparatively few nights, the alcoholic flux was available on at least one hundred nights each year.

COLEOPTERA.

The only beetles taken at the flux were a few small species of STAPHYLINIDAE, which occasionally came and fed at the edges of the masses of flux.

Mr. G. C. Champion informs me that certain species of *Epuraea* and *Cryptarcha* (NITIDULIDAE) are invariably found at sap-exudations. Three species of *Epuraea* have been taken at Wisley on oak trees, but none was found actually feeding on the tree in question.

Fowler (*Coleoptera Brit. Islands*, iii, pp. 225–233 and 260) states that

three species of *Epuraea* (*E. decemguttata*, F., *E. diffusa*, Bris., and *E. variegata*, Herbst) and two species of *Cryptarcha* (*C. strigata*, F., and *C. imperialis*, F.) occur at oak sap, whilst eight other species of the former genus are taken at sap-exudations of various trees often in association with *Cossus* borings.

Eidmann (*Zool. Anz.*, lxv, Nos. 1–2, p. 21) records the favourite food of *Cetonia floricola*, Herbst, when adult, to be the sap that oozes from wounds in the bark of willows and oak trees.

Hemiptera.

This Order provided two chance visitors—*Anthocoris nemorum*, L., and an unidentified species of *Lygus*.

Psocoptera.

Many Psocids were observed to run over the excrescences, and although a few stopped to feed many were caught in the flux.

Other Associations.

On the 21st July, 1924, a common red squirrel (*Sciurus vulgaris*) was observed for several minutes to lick the masses of flux with apparent relish.

A few insectivorous birds were occasionally observed to visit the tree and pick off the various Diptera gathered there. The commonest visitor was the Blue Tit, which preferred the smaller Anthomyiids.

Dr. Waterston (18) has most kindly sent along some interesting observations on similar phenomena occurring on trees in Scotland and Macedonia, which are herewith appended.

" Some thirty years ago when on a holiday at Rachan, near Broughton, Peebleshire, Scotland, in the month of August, I made some notes which have remained very clearly fixed in my mind. A small stream had been impounded to drive a motor supplying electric light. Below the dam was a large pool, which, when the motor was running, went nearly dry during the hot season, and we used to amuse ourselves at such times in catching by hand the trout congregated below the fall. At the side of the pool the stream had washed out the bank and formed a small cave to a depth of several feet. An old willow grew above, its roots penetrating the roof of the cave and forming a thick mat on its floor. One day standing in the almost empty pool I saw something flash by my head and disappear in the dark recess below the bank. Crawling in I saw a Red Admiral butterfly (*V. atalanta*, L.) sitting on the damp soil where one of the roots appeared. This and other roots were then noticed to have a coralline, slimy incrustation which could be shelled off easily, and the soil where they came out was somewhat discoloured. In the course of one afternoon fourteen Red Admirals visited the spot. All behaved like the first, thrusting the ' tongue ' into the wet soil near a root and soon becoming so immobile that they could be picked by the fingers. The number fourteen was, I may say, a greater number of this species than one would have been likely to encounter in a walk of a considerable radius round the place described. The soil had a musty smell around the roots, and I had no doubt at the time that the attraction was some root-exudate probably associated with the slimy covering already noted. This covering did not extend to the portion of the root which normally would have been under water, it seemed to thrive in the moist atmosphere above.

"The above notes refer to but one insect, but during the war, the first week in June 1918, at the mouth of the Rendino River, near Stavros in Macedonia, I saw a remarkable assembling of very diverse insects under conditions recalling in some respects those just noted. Again the attracting tree was a large and old willow standing beside a stream, but the attracting portion was on the trunk and completely exposed (*i.e.* the surrounding air was not unduly moist and fairly static). About five feet from the ground the main trunk gave off a nearly dead branch slanting athwart the stream. In the upper angle was a cupped-shaped hollow in which water, dead leaves and other organic débris had collected. The lower angle was moist with the percolating fluid and slimy in parts, and the damped discoloured area extended irregularly down for over a foot. A strong musty, distinctly alcoholic smell was given off by this damp patch. There were indications of damp lines extending downwards on the trunk, although at the time of my visit there was no actual dripping to be detected. The damp areas were soft—very soft in places—and the wood crumbled like spent tan with little effort. All through the trunk where examined showed felted masses of a fungus mycelium. These notes were made in some detail, for at the time I was investigating all the old trees in the neighbourhood for Culicine breeding-places.

"To the tree I have described insects came in swarms. In the course of an hour or so between thirty and forty *V. polychlorus*, L., appeared. This was indeed the chief butterfly visitor. Many *V. c-album*, L., accompanied the large Tortoiseshell. Several *L. camilla* floated down, and a large fritillary (*A. pandora*) dashed to the spot and had probably come from some distance. On the trunks were numerous beetles—notably three species of *Cetonia* and various Carabidae. Diptera were fairly numerous, and one species (several examples) had gorged itself so greedily on the tan-coloured sap that the liquid oozed out in pinning the specimens. Besides the insects engaged in feeding, a small army of predators skirmished round. Spiders could be seen picking up flies, large grasshoppers (including *Saga*) took their toll aided by *Calosoma*, and on the ground beneath earwigs, etc., waited the fall of the visitors above. Now and then a *Bembex* swooped down and secured a victim. Detached lepidopterous wings suggested that insectivorous birds had frequented the spot.

"The most remarkable thing, however, about this insect assemblage was that for the most part its members were in a perfectly helpless state. One needed no net to collect specimens—they were to be picked off with the fingers or forceps, and in doing this I became aware that for some feet round the base of the tree there were hundreds upon hundreds of insects laid out in regular zones, and here and there on the bushes round about were others hanging by a leg or legs from leaves or twigs they had just managed to reach before being overcome."

I wish to express my sincere thanks to Dr. Waterston for sending me his observations, also to Mr. F. W. Edwards, M.A., and Dr. Keilin for identifying the Diptera and dipterous larvae respectively; to Mr. W. D. Cartwright (Wisley) for supplying me with the meteorological data used in the compilation of the graphs, and to Mr. N. K. Gould for the photographs.

INSECT VISITORS TO WHITE SLIME FLUX OF OAK, 1921–1924 INCLUSIVE.

Hymenoptera-Aculeata.

DIPLOPTERA.

VESPIDAE.	*Vespa germanica*, Fab., neuters. Very frequent daily; a few females seen in late August and September.
	V. vulgaris, Linn., neuters. Fairly frequent.
	V. norvegica, Fab., neuters. Less frequent.

ANTHOPHILA.

APIDAE.	*Bombus lucorum*, Smith, females, neuters. Numerous on sunny days in 1921 and 1922 only.
	Apis mellifica, Linn., neuters. Occasional visitors; on sunny days only.

Diptera.

ORTHORHAPHA-NEMOCERA.

PSYCHODIDAE.	*Psychoda*, undetermined species. Occasional visitors.
CULICIDAE.	*Aëdes punctor*, Kirby. Occasional visitors.
RHYPHIDAE.	*Rhyphus punctatus*, F. Occasional visitors.

ORTHORHAPHA-BRACHYCERA.

DOLICHOPODIDAE.	*Medeterus* species. Occasional visitors.

CYCLORHAPHA-ASCHIZA.

SYRPHIDAE.	*Chrysochlamys cuprea*, Scop. Occasional visitors.
	Larvae of undetermined species. Two found in flux, 1924.

CYCLORHAPHA-SCHIZOPHORA.

(I). Acalyptratae.	
DROSOPHILIDAE.	Larva of undetermined species. One found in flux, 1924.
CORDYLURIDAE.	*Scatophaga stercoraria*, Linn. Frequent visitors, male less so than female.
(II). Calyptratae.	
ANTHOMYIIDAE.	Anthomyiids, several species. Daily visitors in all weathers.
	Phaonia erratica, Fall. One of the most frequent of all the Diptera, especially in July and August.
	P. pallida, F. Occasional.
	P. cincta, Zett. Occasional.
	Mydaea caesia, Mg. Occasional.
	M. impunctata, Fall. Occasional.
MUSCIDAE.	*Mesembrina meridiana*, Linn. Fairly frequent.
	Calliphora erythrocephala, Mg. Very numerous from June to September in all weathers.
	C. vomitoria, Linn. Fairly frequent.
	Lucilia caesar, Linn. Numerous from June to September in all weathers.
	Muscina pabulorum, Fall. Very numerous all the summer.
	Fannia manicata, Mg. Occasional.

SARCOPHAGIDAE. *Sarcophaga carnaria*, Linn. Fairly frequent.
DEXIIDAE. *Dexia rustica*, Fab. Occasional.

Coleoptera.

POLYCERATA.

STAPHYLINIDAE. Staphylinids, several small species. Occasional.

Lepidoptera-Rhopalocera.

NYMPHALIDAE. *Vanessa atalanta*, Linn. Numerous on sunny days, less so on dull days.

Heterocera.

HYDRIOMENIDAE. *Hydriomena bilineata*, Linn. Chance visitors.
DREPANIDAE. *Drepana binaria*, Hufn. Chance visitor.
TORTRICIDAE. Several species. Most of them caught in "flux."

Hemiptera-Heteroptera.

ANTHOCORIDAE *Anthocoris nemorum*, Linn. Chance visitors.
CAPSIDAE. Species undetermined. Casual visitor.

Psocoptera.

PSOCIDAE. Psocids, undetermined species. Numerous, several caught in "flux."

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Explanation of Plates LXV–LXVII.

Plate LXV.

Oak tree growing in wild garden at the Royal Horticultural Society's Gardens at Wisley, Surrey. The main stem is 17 ft. high and bears 77 excrescences. (14.vii.1924.)

Plate LXVI.

One of the largest excrescences showing the fermented sap or "flux" flowing from interstices of bark. (6.viii.1924.)

Plate LXVII.

The excrescence on left of photograph shows the fermented sap overflowing and running down the trunk. (14.vii.1924.)

Em. Crump. Fec.

SAP EXUDATIONS.—Oak tree growing in wild garden at Wisley showing excrescences on trunk (14. vii. 1924).

SAP EXUDATIONS. Fermented sap exuding from interstices of bark [illegible] 1924.

SAP EXUDATIONS. Fermented sap overflowing from excrescence and running down trunk. 14. vii. 1924.

NOTES ON THE BRITISH SPECIES OF *LUCILIA* (DIPTERA)

By O. W. Richards, B.A.

With a Supplementary Note by J. E. Collin.

[Read June 2nd, 1926.]

Plates LXVIII–LXX.

During the identification of some flies that had been taken from the Crabros * (Hym.) which were storing them for their larvae, some trouble was found in giving names to the Lucilias. Mr. A. H. Hamm and Mr. J. Collins of the Hope Department have very kindly allowed me to examine all the male Lucilias in their collections, and the following notes are the result of this examination.

The latest key to the species is that given by the late Dr. Paul Stein (*Archiv. f. Naturges.*, Abt. A, Heft 6, 1924, p. 262), of which the following is a translation.

1. Three acrostichal bristles behind the suture of the mesonotum . . . 2.
— Two acrostichals . . . . 5.
2. Male vertex at the narrowest part at least three times as broad as the 3rd joint of the antenna, belly with thick tufted hairs . *pilosiventris*, Kram.
— Male vertex not more than double as broad as the 3rd joint of the antenna, belly not especially hairy . . . . 3.
3. Second abdominal segment without marginal bristles . . . . *sericata*, Mg.
— Second segment with obvious marginal bristles . . . . 4.
4. Male vertex at the narrowest place scarcely so broad as the 3rd joint of the antenna . . . . *silvarum*, Mg.
— Male vertex at the narrowest place nearly twice as broad as the 3rd joint of the antenna . . . . *longelobata*, Pand.
5. Male vertex at the narrowest place about half as broad as the 3rd joint of the antenna . . . . *simulatrix*, Pand.
— Male vertex at the narrowest place scarcely a quarter as broad as the 3rd joint of the antenna . . . .
6. Central stripe of male vertex at the narrowest place, completely or almost completely disappears. Dorsal margin of forceps straight to the extreme apex; side part of forceps straight and broadly rounded at the end . . . . *flavipennis*, Kram.
— Central stripe of male vertex though linear never quite disappears. Dorsal margin of forceps clearly emarginate; side part of forceps bent and ending in a point . . . . *caesar*, L.

In his notes on the species Dr. Stein adds that *L. sericata*, Mg., may be known in both male and female by the white dusting of the abdomen, which is apparent when the latter is seen very obliquely from behind

Kramer (*Abhandl. Naturforsch. Ges. Görlitz*, 1911) has figured the male forceps of all the species in his " Tachinidae of Oberlausitz " (Plate I, facing p. 144), and in the same journal in 1917 added *L. flavipennis*, Kram. (p. 283 and Plate 1, p. 285). Further, A. Müller (*Archiv. f. Naturges.*, 1922, 88, Heft 2, p. 55 and Plate 1) has figured the penis of all the species. His drawings are presumably from fresh specimens, so that the relations of the chitinous parts

* See " The Biology of British Crabronidae," by Hamm and Richards, this vol., p. 297.

are not always clear. Some of the basal structures have also been omitted. The figures accompanying the present paper were drawn from genitalia that had been treated with potash, dehydrated, and cleared in xylol. The drawings were made while the specimens were in xylol, and are only approximately to the same scale. For each species four figures are given. (A) and (B) show the forceps seen from the side (right) and from above. The forceps consist of an inner pair, enclosed between an outer pair. (C) and (D) show the penis and associated parts also figured from the right side and from above. For these latter figures the parts have been dissected out of the basal part of the genitalia. The presence and the number of bristles on the anterior and posterior process on each side of the penis are specific characters, though in certain cases the number of bristles may vary to a small extent.

Examination of the freshly extracted genitalia with a hand-lens will usually suffice for identification.

The British Species Examined.

L. caesar, L. (Pl. LXVIII, figs. 1*a*, 1*b*, 1*c*, 1*d*.)

This is the common species with closely approximated eyes. The males have occurred near Oxford, both in Oxon. and Berks., from April to August. Mr. Hamm has also a male from Lyndhurst, Hants., 13.viii.03, and one from Newton Abbot, S. Devon., 15.vii.98.

L. simulatrix, Pand. (Pl. LXVIII, figs. 2*a*, 2*b*.)

This is an equally common species, easily known when once recognised by the more widely separated eyes. The penis being identical with that of *L. caesar*, the forceps only are here figured. It has occurred in the Oxford district both in Oxon. and Berks.; the males have been taken from April to Sept. Mr. Hamm found a pupa under a dead blackbird in the University Parks, 14.vii.24, from which a male emerged 18.vii.24. The bird had been laid down quite fresh on 29.vi and larvae were found under it on 9.vii.

L. sp. (**? flavipennis,** Kram.). (Pl. LXIX, figs. 3*a*, 3*b*, 3*c*, 3*d*.)

Two males of this species were taken by Mr. Hamm at Greenham Common, Newbury, Berks., in June 1916, and it has also been found in Oxfordshire. They may be *L. flavipennis*, Kram., but it would be unsafe to dogmatise without comparison with authenticated types. The thick bushy hairs on the posterior margin of the genital capsule are noteworthy.

L. silvarum, Mg. (Pl. LXIX, figs. 4*a*, 4*b*, 4*c*, 4*d*.)

This species is easily recognised. *L. longelobata*, Pand., its nearest ally, has apparently not yet been found in England. Males of *L. silvarum* have been taken near Oxford both in Oxon. and Berks., from May to August.

L. sericata, Mg. (Pl. LXX, figs. 5*a*, 5*b*, 5*c*, 5*d*.)

This, if correctly identified, is not a common species. The dusting of the abdomen mentioned by Dr. Stein I have not been able to observe, and therefore may have been dealing with a different species. The genitalia, however, seem to agree with the figures given by the German authors. Mr. Hamm has taken

one male at Lye Hill, Oxon., 28.iv.12, and one at Barton Mill, Suffolk, 9.viii.01. Mr. Collins took a male at Sunnymeade, near Oxford (Oxon.), 29.viii.24.

L. sp.? * (Pl. LXX, figs. *6a*, *6b*, *6c*, *6d*.)

The only species in Dr. Stein's key to which this might be referred is *pilosiventris*, Kram., from which, however, it differs in having more closely approximated eyes, and in lacking the very bristly belly. Mr. Collin suggests that this species is what has been called *L. splendida*, Mg., in British collections. That species is said to be the only British one in which the male has two antero-dorsal bristles on the mid tibiae. The specimens with a hypopygium as in figure 6 usually have the two bristles, but in very small specimens the upper bristle may be very small and hardly distinguishable.

The thick hairs on the hind margin of the genital capsule are like those of the species figured in figure 3, A. The present species, however, has three not two acrostichal bristles, and the anterior process at the side of the penis has seven bristles, while the posterior has none. This species is common near Oxford both in Oxon., and Berks. The males have occurred from May to August. Mr. Hamm found a pupa under a dead blackbird in the University Parks, from which a male emerged 18.vii.24 (cf. *simulatrix*).

L. bufonivora, Moniez. (Pl. LXX, fig. 7.)

Mr. J. E. Collin found a few specimens of this species in his collection and was able to compare them with bred specimens from the continent. He was kind enough to send me one. It has the two marginal bristles on the 2nd abdominal segment as in *silvarum*, but there are only two or exceptionally one pair of post-sutural acrostichals. The penis seems to me to be almost identical with that of *silvarum*, though there are slight differences of proportion probably due to the greater chitinisation of the whole genitalia. The outer pair of forceps is, however, much broader than in *silvarum* and the genitalia (in the one specimen I have examined) are more bristly. The eyes are distinctly further apart than in *L. silvarum*.

The larva develops in the nostrils and afterwards the head of toads. Mr. Hamm tells me he has seen parasitised toads near Reading many years ago. The specimen sent by Mr. Collin came from Three Bridges (Sussex), 17.vi.92. Since the above was written I have myself taken four males of this species at Windover (Bucks.) on June 22nd, 1926.

The females can scarcely be identified. *L. silvarum* and *bufonivora* are the only British species with the two marginal bristles on the 2nd abdominal segment; however, *L. longelobata*, Pand., which is similar in this respect, may well occur in England. The number of acrostichal bristles is the only other character which is not peculiar to the males, and Mr. Collin finds that this is liable to variation.

In conclusion I must offer my best thanks to Mr. A. H. Hamm and Mr. J. Collins for the use of their material, and also to Mr. J. E. Collin for very valuable criticism.

It may be noted that the process from the outer arm of the forceps (marked *x*, Plate LXVIII, fig. 1*a*) is, in the normal position of the parts, joined on to the process (marked *y*, Plate LXVIII, fig. 1*c*) from the structures associated with the penis. (For Explanation of Plates see below.)

* See Mr. Collin's note, p. 258.

Supplementary Notes on the Genus *Lucilia*, Desv. (Diptera).

By J. E. Collin.

Mr. Richards, in his paper on the British species of the genus *Lucilia*, has made it possible to distinguish, at least the males, with some degree of certainty, but the correct application of a specific name to some of the species is a more difficult matter owing to the very inadequate and often misleading original descriptions of the older authors, and the failure of more recent students to undertake the only work to settle this difficulty, viz. a critical examination of the original types.

Meigen in his *Syst. Beschr.* described, from specimens in the collection of "von Winthem," five species of *Lucilia* as species of *Musca*, viz. *regalis*, *illustris*, *parvula*, *nobilis* and *equestris*. Through the kindness of Dr. Zerny I have been able to examine the specimens standing under these names in the "Winthem" Collection at Vienna.

In spite of some discrepancies between the specimens and Meigen's descriptions in the colour of some parts, which I indicate below, there would appear to be little doubt that they are the original types, for, with the possible exception of *regalis*, they agree very closely in number and sex with the particulars given by Meigen.

Musca regalis, Mg. 1 ♂ 1 ♀. (Male only described by Meigen with no mention of the number of specimens.)

The male is a good and distinct species agreeing with a male in a collection from Kowarz labelled *latifrons*, Schin. It would appear to be the same as *longelobata*, Stein, but can hardly be the *longilobata* of Pandellé, which was described as having the abdomen with the "3e arc. avec les aiguillons médians débiles et couchés." The "Bakken" or jowls are not shining black, but, from most points of view distinctly dusted greyish (as usual in *Lucilia*). Palpi dark. Halteres not "schwarzlich," but distinctly yellowish with somewhat darkened stem. Frons about 2½–3 times as wide as the dorso-ventral width of third antennal joint. Three pairs of post-sutural acrostichals. Third abdominal tergite (the apparent second) with two pairs of strong stout macrochetae at middle of hind margin somewhat as in *silvarum*. Fourth tergite very bristly; and sides of third tergite, and the parts of third and fourth tergites which are more or less ventral, more strongly bristled than usual. Lobes of last sternite long. Middle tibiae with two antero-dorsal bristles and all bristles on legs rather longer and stronger than usual. A yellowish sclerite at extreme base of costa as in *sericata*.

The female is not the same species, it is smaller, has only one antero-dorsal bristle to middle tibiae, a darker sclerite at extreme base of costa, and is a female of *silvarum*.

It would appear obvious that the name *regalis* must be used for the male.

Musca illustris, Mg. 1 ♂ 1 ♀ pinned on one pin (a very usual method of indicating a pair taken *in coitu*). (Both sexes described by Meigen "von Herrn v. Winthem, in Paarung gefunden.")

This pair represent one of the larger forms of *simulatrix*, Pand. The palpi are not black as stated by Meigen, but distinctly yellowish. The frontal stripe of male is very narrow at the narrowest part, but this is not unusual in specimens which are somewhat immature; the frontal orbits which are not so liable to variation are equal in width to those of typical *simulatrix* (somewhat wider than in *caesar* or *flavipennis*).

It is apparently necessary to sink *simulatrix*, Pand., as a synonym of *illustris*, Mg.

Musca parvula, Mg. 2 ♂♂. (Male only described by Meigen from "zwei Exemplare von Herrn v. Winthem.")

These two specimens appear to be a rather small green form of *simulatrix*, Pand. The palpi are not black as stated by Meigen. Frontal stripe narrow. The frontal bristles are rather shorter than in typical *simulatrix*,and the antennae (including arista) have a reddish-yellow tinge. The abdomen has the same greyish dusting on the first tergite and at sides beneath of other tergites as in *simulatrix*, but the general pubescence of abdomen and especially the bristly hairs at hind margin of third tergite are somewhat shorter.

This is the only one of the "von Winthem" five species of which representatives are also to be found in the Meigen Collection at Paris. The Paris specimen of *parvula* is not, however, a *simulatrix*, it has the sclerite at the base of costa yellow, and in M. Séguy's opinion is a specimen of *sericata*. There is every reason to believe that this was not one of the "two specimens" mentioned by Meigen when he described the species, but a subsequent addition.

Musca equestris, Mg. 1 ♂. (Male only described by Meigen "von Herrn v. Winthem nur ein Exemplar.")

A still smaller bluish-green form of *simulatrix*. The "Bakken" may appear blackish, as stated by Meigen, when viewed from in front towards beneath, but are really dusted greyish and not different from those of typical *simulatrix*.

Musca nobilis, Mg. 1 ♂ 1 ♀ (small), 1 ♀ (large). (Meigen described it from "beide Geschlechter von Herrn v. Winthem aus Hamburg; hier ist diese Art noch nicht vorgekommen. 3 Linien, auch etwas gröszer.")

These are three specimens of *sericata* with the sclerite at base of costa whitish-yellow and the greyish sheen on abdomen.

The male does not agree with Meigen's description, inasmuch as the frontal stripe is reddish and not black. The frons is rather narrow for *sericata* (apparently due to immaturity), but the tiny hairs outside the frontal bristles are numerous and multiserial as in *sericata*. It is very much like a specimen labelled *L. juvenis*, Rdi., in Bigot's Collection. In *sericata* there is usually a more or less distinct central dark stripe on at least the second abdominal tergite, as mentioned by Meigen in his description of *nobilis*.

M. E. Séguy of the Paris National Museum, to whom I am indebted for pointing out the important character in the colour of the "basicosta" (the costal sclerite devoid of bristles close to the base of wing), has examined the specimens of *Musca splendida* in Meigen's Collection at Paris—the probable types—and tells me that they have only one antero-dorsal bristle to middle tibiae and are probably specimens of *L. caesar*, therefore the name *splendida* cannot be used (as it has been in the British "List of Diptera") for our species with the two antero-dorsal bristles to middle tibiae (*pilosiventris* of Mr. Richards' paper). Nor can I agree to the use of the name *pilosiventris*, Kram., for this species because I possess a continental male specimen which, though having the basicosta yellow and two antero-dorsal bristles to middle tibiae as in our British specimens, has a very much wider frons and more densely long-haired abdominal sternites. I therefore propose to give our British species the new name of **L. richardsi**.

Mr. Richards' identification of *L. flavipennis*, Kram., is probably correct. I possess a male taken at Lyndhurst (Hants.) on May 29th, 1897, and have seen specimens from Nottinghamshire.

I append a short table of the seven British species which can be used as a check upon results obtained by the use of the table given in Mr. Richards' paper.

1. (4) Basicosta yellowish.
2. (3) Two antero-dorsal bristles to middle tibiae . . . *L. richardsi*, n.n.
3. (2) Only one antero-dorsal bristle to middle tibiae . . . . *L. sericata*, Mg.
4. (1) Basicosta dark.
5. (10) No strong macrochetae on third (apparent second) abdominal tergite.
6. (7) Male hypopygium larger . . . . *L. caesar*, L.
7. (6) Male hypopygium smaller.
8. (9) Eyes in male more approximated on frons, or at least the frontal orbits rather narrower (more as in *caesar*) . . . . *L. flavipennis*, Kram.
9. (8) Eyes in male wider apart on frons or at least frontal orbits somewhat wider . . . . *L. illustris*, Mg.
10. (5) At least two strong macrochetae at middle of hind margin of third abdominal tergite.
11. (12) Three pairs of postsutural acrostichals . . . . . *L. silvarum*, Mg.
12. (11) Only one or two pairs of postsutural acrostichals . *L. bufonivora*, Mon.

Explanation of Plates LXVIII–LXX.

Plate LXVIII.

Fig. 1. Genitalia of *Lucilia caesar*. A and B forceps from the right and from beneath (true dorsal). C and D penis from the right and from beneath (true dorsal). N.B.—The penis has been dissected out, but in its natural position the projection marked *x* in fig. 1*a* is continuous with that marked *y* in fig. 1*c*.

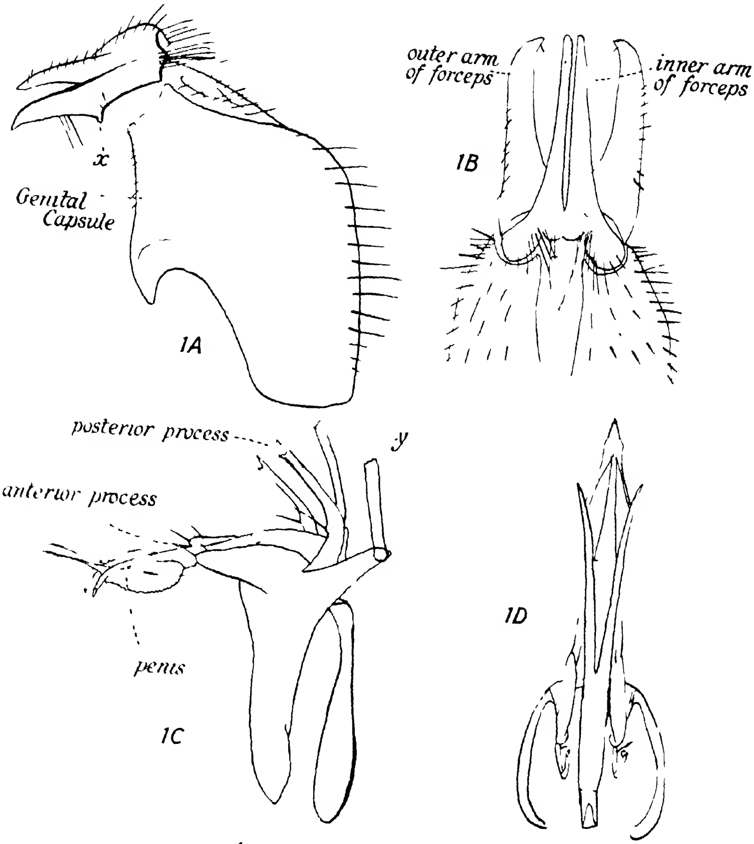
2. Forceps of *L. simulatrix*, A from the right, B from beneath.

Plate LXIX.

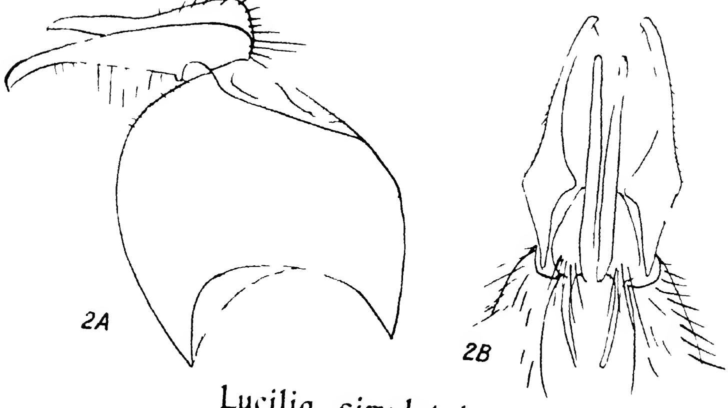
3. A and B forceps, C and D penis, of *L. flavipennis*.
4. A and B forceps, C and D penis, of *L. sylvarum*.

Plate LXX.

5. A and B forceps, C and D penis, of *L. sericata*.
6. A and B forceps, C and D penis, of *L.* sp.
7. Forceps of *L. bufonivora*.



Lucilia caesar

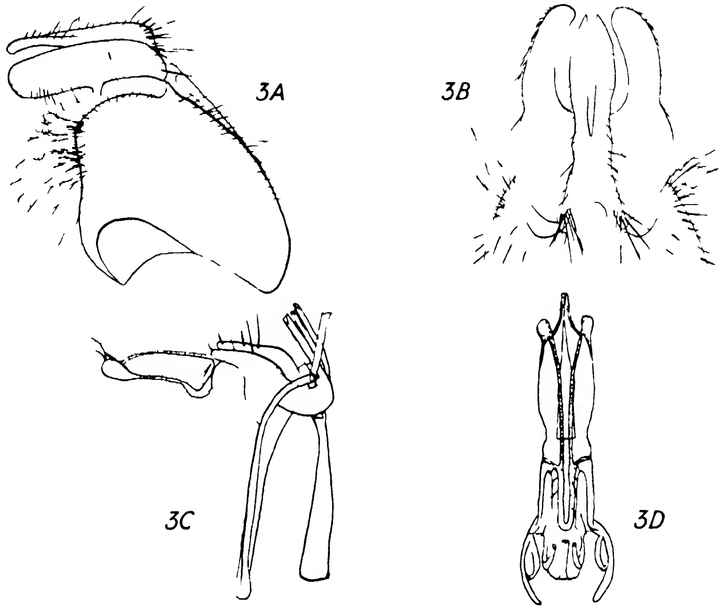


Lucilia simulatrix

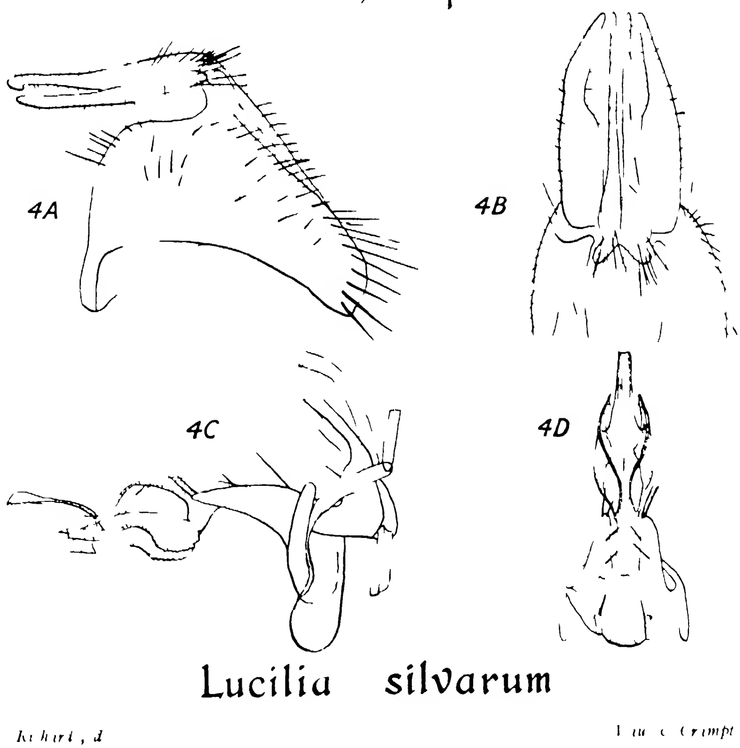
O. W. Richards del.

Laus & Crampton, Ltd.

THE BRITISH SPECIES OF LUCILIA.



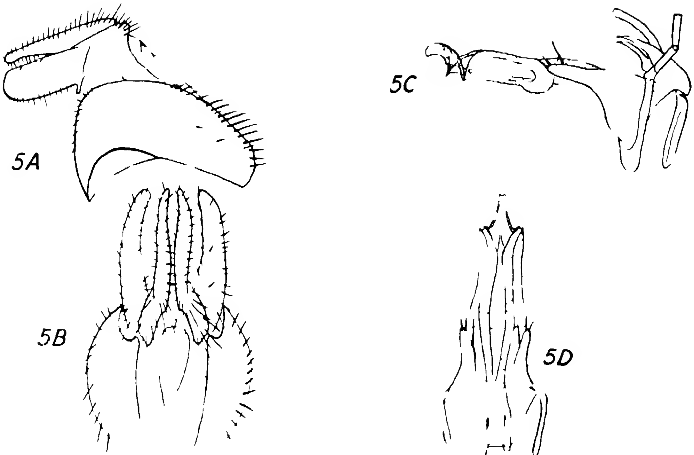
Lucilia flavipennis



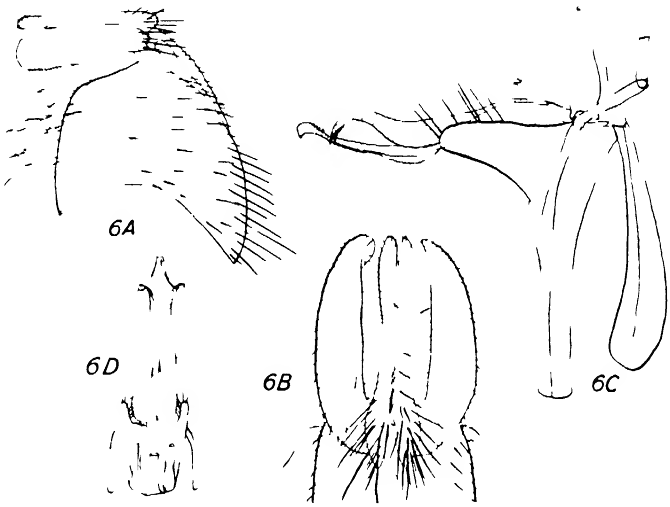
Lucilia silvarum

O. W. Richards, del. [illegible] Crompton, Ltd

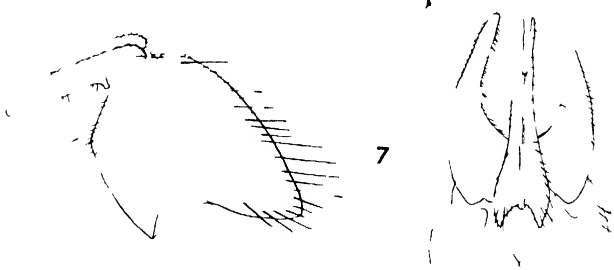
THE BRITISH SPECIES OF LUCILIA



Lucilia sericata



Lucilia sp.



Lucilia bufonivora

O W Richards, del Vaus & Crampton Ltd

TERATOLOGICAL COLEOPTERA: HETEROMORPHOSIS, REDUPLICATION OF LEG, INCOMPLETE UNION OF PRONOTUM

By E. A. Cockayne, D.M., F.R.C.P.

[Read June 2nd, 1926.]

Plate LXXI.

Mr. S. R. Ashby has kindly allowed me to describe the following teratological Coleoptera in his collection. The first specimen, an example of heteromorphosis, is so far as I am aware unique; the second is an example of a triple tibia and tarsus with partial fusion, in which reduplication has taken place in a ventral direction. Reduplication in a dorsal or ventral direction at right angles to the long axis of the insect, vertical reduplication, is much rarer than horizontal reduplication in an anterior or posterior direction in the long axis of the insect. The third specimen is an example of incomplete union of the pronotal plates. This uncommon defect is due to an arrest of development and in the majority of cases the plates are completely separated. In the *Trans. Ent. Soc. Lond.*, 1925, p. 399, pl. xliv, fig. 6, I described and figured one and gave references to others, but forgot to mention those collected by Bateson, *Materials for the Study of Variation*, 1894, pp. 454–456, and have found two more reported by L. Chinaglia, *Riv. Col. Ital.*, 1912, x, pp. 15–16. In these lists there are seven examples in *Melolontha vulgaris*, F. (Lamell.), in two of which division is incomplete, two in *Oryctes nasicornis*, L. (Lamell.), one incomplete, two in *Bubas bison*, L. (Lamell.), and one in each of the following species, *Geotrupes stercorarius*, L. (Lamell.), *Heterorhina nigritarsis*, Westw. (Lamell.), *Xylotrupes minos*, Kolbe. (Lamell.), incomplete, *Carabus scheidleri*, F. (Carab.), *Carabus lotharingus*, Dej. (Carab.), incomplete, *Amara familiaris*, Duft. (Carab.), *Brachinus crepitans*, L. (Carab.), *Telephorus nigricans*, F. (Malac.), *Chrysomela fucata*, F. (Phytoph.), *Timarcha metallica*, F. (Phytoph.), *Attelabus curculionoides*, L. (Rhynch.), *Otiorhyncus moestus*, Gyll. (Rhynch.), *Lixus angustatus*, F. (Rhynch.), and several in *Tenebrio molitor*, L. (Heterom.), in which it was proved not to be hereditary. Similar defects of the thoracic plates must occur in other orders, but I do not know of any records. In Lepidoptera a *Manduca atropos*, L., with two death's-head markings on the thorax is reported by Swoboda, *Intern. Ent. Zeitschr.*, 1909, iii, p. 2, and in the Horne collection there was another with a very narrow thorax on which only a little of the anterior part of the death's-head mark was present. In both there was probably a partial or complete failure in the union of the mesoscutum.

Apion fuscirostre, F. (Rhynch.).

(Plate LXXI, fig. 4.) Esher, 6.ix.1903.

The left prothoracic leg is abnormal. The femur is very broad, ends bluntly and is entirely black instead of being black in its proximal and light brown in its distal part. From its dorsal surface arises a trochanter and another femur almost like a normal femur in its shape and colour, but with its ventral surface uppermost. From the second femur arises a rather short tibia, which also lies with its ventral surface uppermost. There is no tarsus and in all probability there has never been one. The rest of the beetle is normal.

The abnormal leg is an example of heteromorphosis, in which a trochanter and femur replace the tibia, and a tibia the tarsus. The specimen resembles in some respects the *Anchomenus oblongus*, F. (*Trans. Ent. Soc. Lond.*, 1925, p. 400, pl. xlv, figs. 1 and 2), in which a tarso-tibia replaces the tarsus of the right metathoracic leg and a complete extra part, a tarsus, arises from its distal end.

Carabus nemoralis, Müll. (CARAB.). Male.
(Plate LXXI, fig. 2.) W. West Collection.

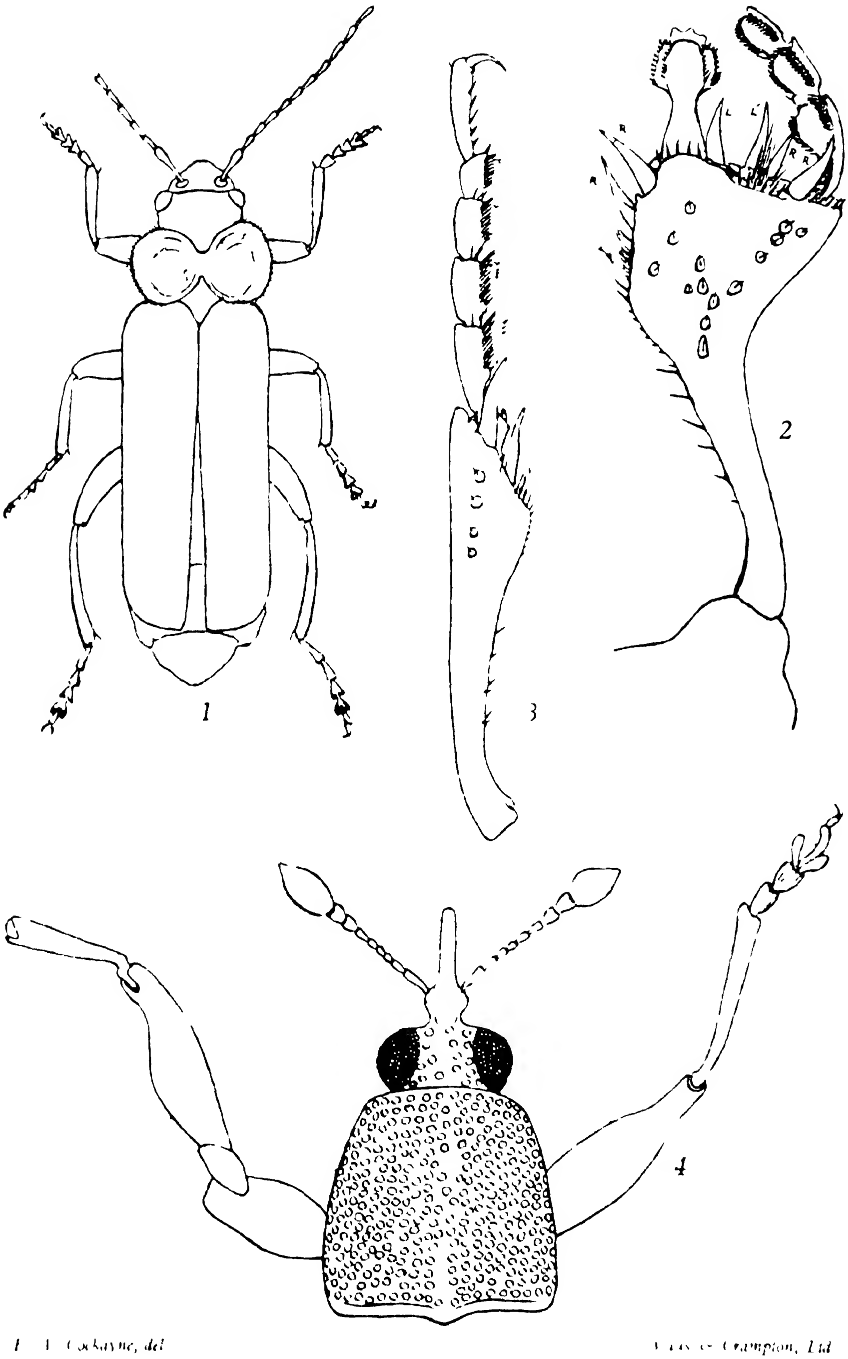
The tibia of the right prothoracic leg is bent ventrally and greatly expanded towards its distal extremity and is really composed of three parts fused together, a dorsal part, which is a continuation of the normal or original tibia, and two extra parts fused dorsum to dorsum, the more dorsal of which has its ventral surface fused with that of the original tibia. Its triple nature is shown by the presence of fourteen pits, each with a hair in the centre, roughly grouped into three rows instead of four pits in a single row. The position of the six large spines or calcaria also clearly indicates that this is the arrangement. A tarsus with only three segments arises from the original tibia, and from the fused extra tibiae springs a double tarsus, each part consisting of a single segment. The two segments are fused together dorsum to dorsum, so that the brush-like walking pad of the one faces upwards and that of the other downwards. The more dorsal part of the double tarsus is a mirror image of the ventral part of the original tarsus and the more ventral part is a mirror image of the more dorsal part. Between the tarsus and the two calcaria, R, belonging to the original tibia, and the tarsus and two calcaria, L′, belonging to the first supernumerary tibia, are two groups of stiff bristles one belonging to each tibia. A third group of similar bristles is present on the ventral aspect of the second supernumerary tibia below its two calcaria, R′. There are also groups of short marginal spines arranged in like manner. Although in minor respects the parts are imperfectly developed in their general disposition they are in accord with Bateson's Law, as can be seen by comparing the diagram of the normal left (Plate LXXI, fig. 3) leg with the abnormal one.

Telephorus rusticus, Fall. (MALAC.).
(Plate LXXI, fig. 1.) Kingsdown, near Walmer, 9.vi.1903.

The pronotum is almost divided into two separate portions, that on the right being the larger. There is a dark mark on each. Where the plates are completely separate the inner margins are like the anterior margins in structure, but are devoid of the fine hairs. In this respect they differ from some recorded specimens of the same kind, which have the fringe of hairs continued round along the inner edges of the plates.

EXPLANATION OF PLATE LXXI.

FIG. 1. *Telephorus rusticus*, Fall., with divided pronotum.
2. *Carabus nemoralis*, Müll., with right prothoracic leg showing triple tibia and tarsus with partial fusion. Reduplication has taken place in a ventral direction.
3. *Carabus nemoralis*, Müll. Normal leg for comparison with fig. 2.
4. *Apion fuscirostre*, F., with abnormal left prothoracic leg.



E. A. Cockayne, del. *Vaus & Crampton, Ltd.*

TERATOLOGICAL COLEOPTERA

ON THE ABDOMINAL GLANDS IN *COLAENIS, DIONE* AND *EUEIDES* (LEPIDOPTERA)

By H. ELTRINGHAM, M.A., D.Sc., F.Z.S.

[Read June 2nd, 1926.]

PLATE LXXII.

IN our *Transactions* for 1925 (p. 269) I gave some account, with illustrations, of the structure of the abdominal glands in *Heliconius*. The material for this research was kindly supplied to me by Dr. C. L. Withycombe, now of the Department of Zoology at Cambridge. I have to express to him my gratitude for sending me further material including examples of *Eueides aliphera*, Godt., *Colaenis julia*, Fab., and *Dione vanillae*, Linn. In my previous paper I mentioned on p. 274 certain features of the glands in *C. julia*, but the acquisition of further examples of this and other species makes it desirable to give a more complete account of these structures in the genera closely allied to *Heliconius*.

It will be recalled that the glands which are considered to have a repugnatorial function are found in both sexes, and were partly described by Fritz Müller early in the nineteenth century. A translation of his papers on these subjects is given in the appendix to Longstaff's "Butterfly Hunting in many Lands" (London, 1912).

The butterflies belonging to the genera *Heliconius*, *Eueides*, *Colaenis* and *Dione* were called by Müller the "Maracujá butterflies," as their larvae feed on species of Passion Flower. In the females there is a large eversible gland between the last and penultimate segments of the abdomen, and placed on each side of this gland is a club-like organ, on the emergence of which the odour is increased in intensity. I was able to show that this distributing organ does in fact communicate with the interior of the gland. Müller has described the external features of these "stink-clubs" in all four genera, together with the specialised scales which are found upon them. The female gland and club in *Heliconius hydarus*, Hew., will also be found illustrated and described in my paper above referred to. The only female example amongst the material recently received from Dr. Withycombe was one of *Colaenis julia*, and in this case the sections seem to show that the structure does not differ materially from that in *H. hydarus*.

Colaenis julia. ♂.

On examining the terminal segments of the male of this species we can discern the structures shown on Plate LXXII, fig. 2. The claspers contain a large gland *cg* as in *Heliconius*, but there is also a kind of auxiliary gland *ag*, which, from this point of view, looks like a somewhat pyriform lobe with slight indications of an invagination on the ventral side. The whole auxiliary gland is enclosed in a delicate chitinous membrane having small, more or less pointed processes, and these under a high power show a structure strongly suggestive of the existence of fine pores, though I have not been able definitely to confirm this. Fig. 5 is a view of the clasper from its inner side, with the auxiliary gland, *ag*, and fig. 6 is a more highly magnified view of part of the cuticle or membrane. If the larger or clasper-gland be removed from the chitinous cuticle of the clasper it does not present the "tea-cosy" shape which I described

in *Heliconius*, but has a more complicated and plicate structure. With the chitin thus removed the substance of the gland is soft and sections are easily obtained by ordinary paraffin embedding.

Such a section stained with iron haematoxylin is shown at fig. 7. Here the rather complicated folding of the parts can be seen. The actual external orifice, which can be observed under a low power in the undissected clasper, is at *eo*, the other apparent openings being due to sectioning across the folds. In structure the gland resembles that of *Heliconius* in so far as it consists of a layer of glandular cells, *gl*, upon which rests, in the lumen of the gland, a thick membrane *m*. Here, however, the resemblance ceases. The membrane, instead of being continuous and transversely striated as in *Heliconius*, is a delicate, reticulated, and apparently spongy mass, rather closer in texture on the side distant from the gland-cells, *i.e.* the surface bordering on the lumen of the gland. Moreover it differs also in the appearance of the gland-cells under a high power. On referring to Plate XXXIII, fig. 8, of our *Transactions* for 1925 it will be seen that the gland-cells in *Heliconius* are vacuolated and provided with a distinct external border, probably poriferous. In *C. julia*, the gland-cells, which are on the average larger, show no marked structure. Two of these cells are illustrated at fig. 12, Plate LXXII, and, as will be seen, they are merely heavily nucleated cells with a finely granular and apparently structureless cytoplasm.

The auxiliary gland presents several rather different aspects according to the direction in which it is cut. Fig. 11, Plate LXXII, is a section taken near the middle of it, in what may be called a transverse direction. There is a thick membrane corresponding with *m* in fig. 7, but denser, more striated, and not spongy, and there is a layer of gland-cells. From the fact that in the section (fig. 11) the gland-cells are bordering on the central space, it would appear, from analogy with the clasper-gland, that this space is not a section of the lumen of the gland, but a blood-space. It is to be supposed that the cells excrete towards the thick membrane, and from this I am inclined to believe that there is a certain amount of secretion from this auxiliary gland, independent of the secretion of the clasper-gland. The cells with which it is lined differ in appearance from those of the clasper-gland. Two of them are shown under a high power at fig. 9 and they have a strong resemblance to the gland-cells in *Heliconius* above referred to. Whether the clasper-gland and the auxiliary gland are internally connected I have been unable to determine with certainty. Both are embedded proximally in a meshwork of delicate membranes and hard chitin, but I incline to the belief that there is some connection.

Dione vanillae. ♂.

In this species the auxiliary gland is much more highly developed and is as large as that part of the clasper-gland which is homologous with the same structure in *Heliconius*. The clasper-gland is, however, itself more highly developed and is extended backwards, *i.e.* towards the abdomen, into a great lobe which is housed in the proximal part of the clasper. There is also no question of the continuity of the whole glandular structure. The ventral appearance of the claspers, etc., is shown in fig. 1, where *cg* is a projection of the clasper-gland itself and *ag* is the auxiliary gland, which is more or less plicate and projecting. Both have a thin chitinous envelope. If the whole of the chitinous covering of the clasper be carefully removed without tearing the soft substance of the glands, the latter appear somewhat as in fig. 4, where the two lobes on the left, *cg* and *ag*, are the clasper- and auxiliary-glands respectively and

the portion to the right, *icg*, is the deep-seated extension which projects back into the base of the clasper. A horizontal section of the entire structure presents the appearance shown at fig. 8, where *cg* is the clasper-gland, *ag* the auxiliary, and *icg* the extension or inner clasper-gland. Evidently the external orifice lies between the two glands and the lumen extends right up into the extension. The whole system is lined with a layer of glandular cells varying in thickness. In the inner or extended part, these cells, though generally smaller, present the same appearance under a high power as the cells of the clasper-gland in *C. julia*. Two are shown at fig. 13, and apart from the different position of the nuclei and the projecting basal portion, they show only a finely granular and apparently structureless cytoplasm. The cells of the clasper- and auxiliary-glands appear, however, to be more complicated. Two are shown at fig. 10. There is a distinct border, somewhat striated, and the cytoplasm is also much striated and contains vacuoles in a granular reticulate matrix. A curious feature is that in the clasper-gland, *cg*, the area *m*, nearest the central lumen, appears solid or nearly so. It has somewhat the appearance of the thick membranous linings found in *Heliconius* and *Colaenis*, but while showing slight striation is also very finely granular. The corresponding area in the auxiliary gland seems to contain little or nothing. Both, however, on the inner surface are bordered by a slightly chitinised layer *ch*, having fine striae, which may be the indication of pores.

Eueides aliphera. ♂.

A ventral view of the claspers has the appearance shown in fig. 3. Its arrangement is in all respects similar to that of the homologous structures in *Heliconius*. There are glands *cg*, in the claspers, of a comparatively simple nature, but no auxiliary glands, and their appearance in section is so similar to that in *Heliconius* (as figured in *Trans. Ent. Soc.*, 1925, Plate XXXIII, fig. 4), as to make more detailed description superfluous.

Examination of these glands therefore shows that the recognised close affinity between *Heliconius* and *Eueides* is confirmed by the position and structure of these highly specialised organs. On the other hand, it indicates a very close relationship between *Heliconius*, *Colaenis*, and *Dione*, and in spite of the open discoidal cell in the two latter genera, it might well be argued that they should be regarded as belonging to the Heliconides. The only other Lepidoptera at present known to have glands in the claspers are moths of the genus *Rhodogastria*, and these glands are of a very different structure and probably function. Though the odour produced by the clasper-glands in *Colaenis* and *Dione* is said to be different from that produced by *Heliconius*, it would seem to be unpleasant in all cases, and also to be similar to that produced by the female glands, though further and more accurate investigation is much to be desired.

The knowledge that all the "Maracujá" butterflies have scent-scales or androconia in the males, coupled with the fact that there are abdominal glands in both sexes which produce a secretion unpleasant to our senses, has rather naturally given rise to the theory that these glands must be purely repugnatorial in function. It seems, however, to the present writer that much additional evidence is required before we can regard this theory as definitely established. The odour in *Heliconius* is said by Dr. Withycombe to resemble that of the very evil-smelling substance carbylamine. As he has made repeated observations and has had them confirmed by others, we may regard this as established. Whatever the actual secretion may be, however, it would seem to be of an unstable character. Dr. Withycombe himself states that after a time the odour seems to become modified into something very like sweet-briar. There is also

a further complication. Dr. Withycombe very kindly sent us an alcoholic extract of the glands, and when it first arrived its resemblance to carbylamine was confirmed here by those familiar with that substance. Some time later my friend Professor Poulton handed me the tube, and I at once pronounced the odour to be that of *Hamamelis*, or witch-hazel. I was at the time ignorant of the existence in the Hope collections of a specimen of *Heliconius hydarus*, taken by the late Dr. Longstaff and labelled by him when caught as having the odour of witch-hazel.* A specimen of *Dione vanillae* in the same collection is labelled by the late Dr. Longstaff as smelling like "stables," from which we may suppose that it had a more or less ammoniacal odour.

Whether witch-hazel has a pleasant or unpleasant smell is a matter of opinion. To me it is unpleasant, but in any case we have evidence that the secretion at different stages changes from the very foul-smelling carbylamine to the pleasant perfume of sweet-briar, *via* the rather doubtful scent of witch-hazel.

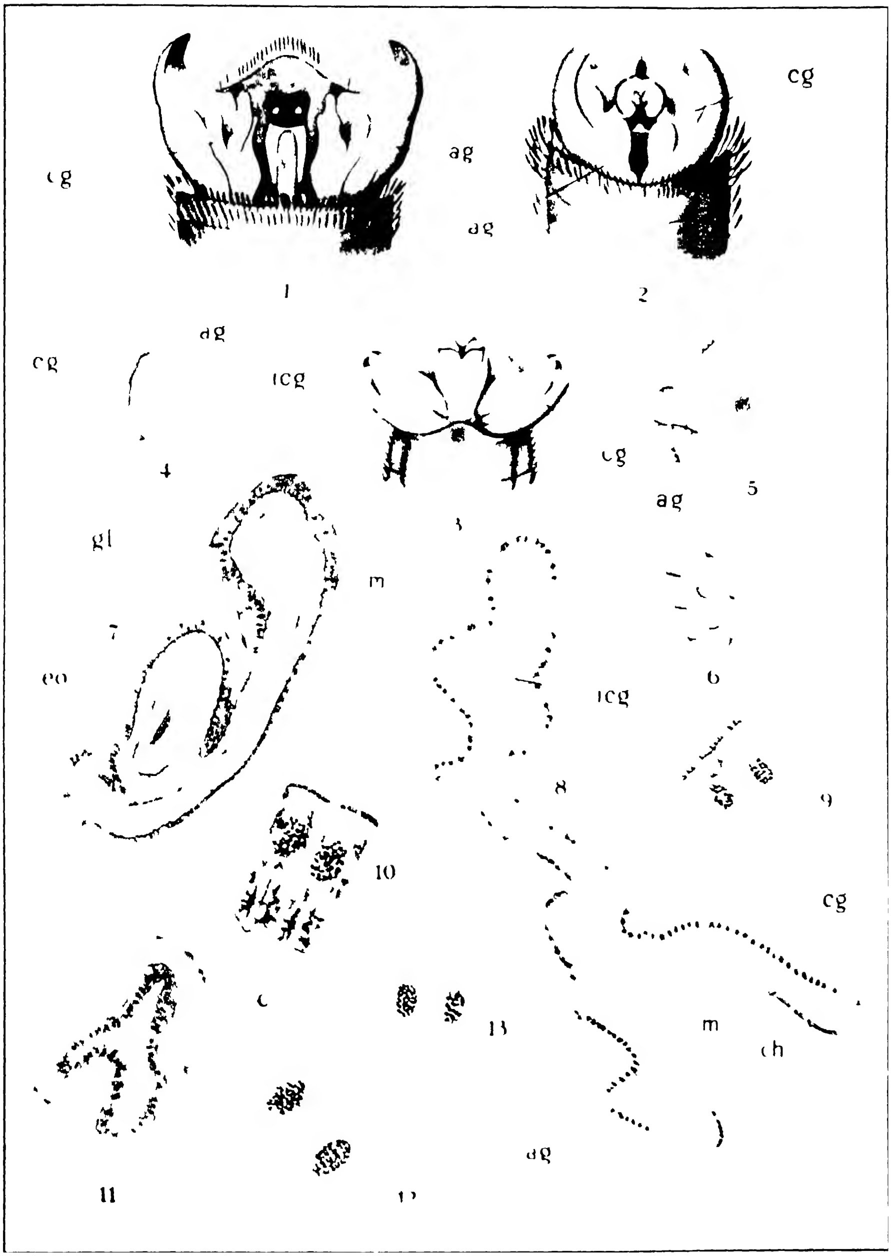
Whatever the purpose of the secretion of the female glands, the position of those of the male, situated as they are in so essential a part of the male sexual apparatus as the claspers, seems to point to some definite sexual character. How complicated scent-organs can be we know from the study of these structures in the Danaine butterflies and in the genus *Hydroptila*. The fact that the fresh secretion of the glands in *Heliconius* is unpleasant to the human sense is not necessarily evidence that it may not have an attractive or excitative function in the economy of the insects themselves. Some mammalian secretions of sexual significance are unpleasant to us. We might even suppose that if an insect such as *Heliconius* had developed a secretion which was unpleasant to its enemies and attractive or excitative to its own species, such a product might serve the double purpose of an amatory and repugnatorial function. The whole question seems to afford a very interesting subject for research by those able to observe the insects in their natural habitat.

Explanation of Plate LXXII.

Fig. 1. Claspers and glands of *Dione vanillae* ♂ viewed from beneath. *cg* clasper-gland, *ag* auxiliary gland.
2. Ditto of *Colaenis julia* ♂. *ag* auxiliary gland, *cg* clasper-gland.
3. Ditto of *Eueides aliphera* ♂. *cg* clasper-gland.
4. Glands of *D. vanillae* removed and seen from the side. *cg* clasper-gland, *ag* auxiliary gland, *icg* extension.
5. View of the inner side of clasper of *C. julia*. *ag* auxiliary gland.
6. Part of cuticle of auxiliary gland of *C. julia*.
7. Section of clasper-gland of *C. julia*. *gl* gland cells, *m* lining membrane, *eo* external orifice.
8. Glands of *D. vanillae*. *icg* internal clasper-gland, *cg* clasper-gland, *ch* chitinous membrane, *m* solid substance, *ag* auxiliary gland.
9. *C. julia*, cells of auxiliary gland.
10. *D. vanillae* cells of auxiliary gland and of clasper-gland.
11. *C. julia*, section of auxiliary gland.
12. *C. julia*, cells of clasper-gland.
13. *D. vanillae*, cells of internal extension of clasper-gland.

The magnifications vary. The actual greatest diameter of section, fig. 11, is ·13 mm. The greatest length of section, fig. 8, is 1·8 mm. The length of cells in fig. 8 varies from 0·2 to ·12 mm.

* An excellent account of these scents is given by Professor Poulton in our *Proceedings*, 1925, pp. xxxvii-xli.



ABDOMINAL GLANDS IN COLAENIS DIONE AND EUEIDES

ON THE STRUCTURE OF AN ORGAN IN THE HIND-WING OF *MYRMELEON NOSTRAS*, FOURC.

By H. ELTRINGHAM, M.A., D.Sc., F.Z.S.

[Read June 2nd, 1926.]

PLATE LXXIII.

SOME time ago my friend Mr. Hugh Main gave me a living male of the common Ant-lion *Myrmeleon nostras*, Fourc., which he had bred from a larva taken by him near Hyères. He had noticed that there was a curious scent given out by the insect, and suggested that I might be able to discover some organ which could be associated with its production. The scent itself I was unable to perceive though possibly the insect had ceased to produce it by the time it came into my possession. The only organ I was able to discover was a small projecting structure near the base of the hind-wing, and as I cannot find any previous mention of it, it seems desirable to give a short account of its appearance and histology.

At Plate LXXIII, fig. 1, is a drawing of the metathoracic region of the insect with part of the attachment of the hind-wings. At *o* there is a small club-like projection which, under a moderate power, shows a tuft of setae mainly disposed on the upper and outer side. The structure is only found in the males, and I have observed it in *M. pubiventris*, Walk. (Amazon), *Glenoleon pulchellus*, Ramb. (Australia), *Periclystis circuiter*, Walk. (Australia), in a species of *Acanthaclisis*, and in all the species of *Palpares* examined. Having up to the present only one example to work from I have not been able to make so complete an examination as I should have wished. The organ from one wing was mounted whole and that from the other was used for making sections.

Plate LXXIII, fig. 2, shows the appearance of the organ under a low power. The outer envelope is of thin chitin having a roughened surface and the greater part of the club exhibits a spotted appearance probably due to the development of the underlying hypodermal cells. At the extremity is a tuft of chitinous bristles. Under a higher power as at fig. 3 the bristles or setae are seen to be fairly stout and for the greater part of their length are of circular section, though towards the extremity many of them become spatulate. There is no marked surface structure. Each arises from a very conspicuous socket, and the wall of each seta is thick, leaving a tubular centre. A small broken piece is shown at fig. 7.

Sections of the organ show that the greater part of the interior is merely a blood space and except in the area of the setae no special modification of the hypodermal cells is evident. Fig. 5 shows a section of this unmodified area. There is a thin hypodermal layer *h*, including scattered cells which contain either large darkly staining granules or many small nuclei. The outer surface of the cuticle has a few very small processes *pp* as shown on the upper side of this figure.

A somewhat different arrangement is found in the area covered by the setae. A section of this portion is shown at fig. 4. The chitin is thicker, there is the same hypodermal layer, but the sockets of the setae have a rather complicated structure and at the base of each is a specialised cell. This structure is shown

more highly magnified at fig. 6. The socket contains several form bodies, each with a small darkly staining nucleus *n*, and the large cell *sc*, is vacuolated towards the socket. At its apex there is a minute structure having a tube-like appearance, and the vacuole has a marked internal border, the remainder of the cell being finely granular and radially striated.

It is scarcely possible to decide whether this cell is a gland-cell producing a volatile secretion which is distributed by the setae, or whether it is merely a trichogenic cell secreting the chitin which forms the seta itself. I incline, however, to the former theory on the ground that if it were a trichogenic cell its function would largely have ceased when once the imago was developed, and hence we should expect it to be partly atrophied or degenerate. Larval trichogenic cells sometimes resemble this in structure but they remain active during the greater part of the larval life to provide for the successive moults. The special cells in these organs of *Myrmeleon* appear to be functionally active, and their activity as mere trichogenes would appear to be unnecessary, once the setae have been developed. On the other hand the cells, if glandular, are not numerous, and their size and numbers would seem to be somewhat inadequate considering the capacity of the organ as a whole. While the setae do not show evidence of pores either over the general surface or at the extremities, the chitin at the spatulate ends may be thin and pervious. As an alternative, the secretion, if any, may find its way along the outsides of the setae by capillary action.

The organ is not one of sense. In outward appearance it inevitably reminds one of the halteres of Diptera, but there the resemblance ends. Nervous tissue or connections are not evident. Its existence argues a function, and its presence only in the males suggests that the function has a sexual character. We are now so familiar with the many manifestations of male scent apparatus that even though simple in structure, there seems no alternative but to suppose that the present organ must be placed in that category.

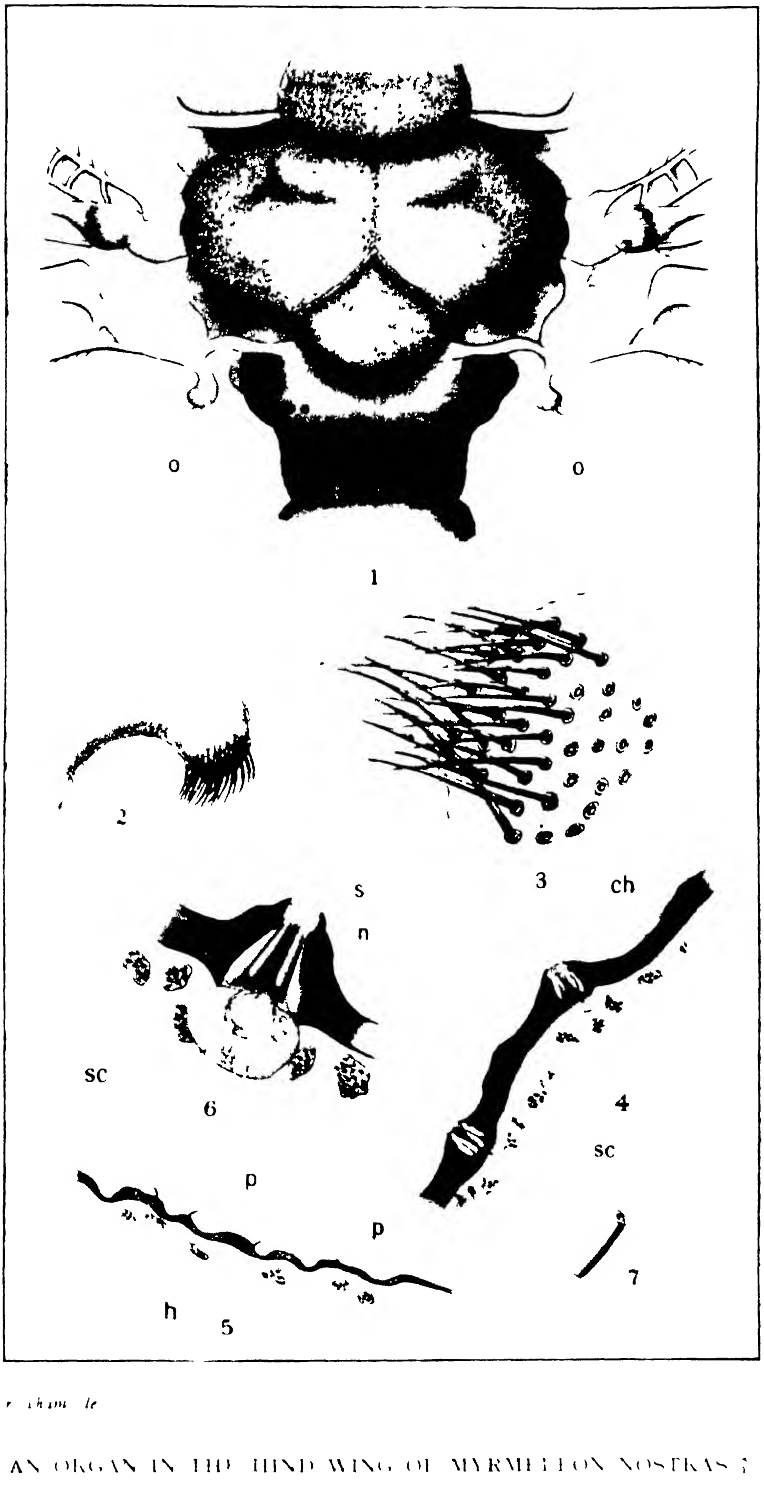
Since the above was written I have heard from my friend Dr. Tillyard to whom I sent a rough sketch and a short account of the organ. He has observed it in a number of males of these and nearly related insects. He states that they all have a strong scent at times and that probably this organ is the seat of its production. At the time of writing he was unaware of any previous description of its histology.

Explanation of Plate LXXIII.

Fig. 1. *Myrmeleon nostras*, Fourc. Magnified view of the metathoracic region with part of the bases of the hind-wings. *o* the supposed scent-organ.

2. The organ more magnified.
3. Part of same still further enlarged, showing setae and their sockets.
4. Section of cuticle of organ. *ch* chitinous cuticle, *sc* special cell at base of socket.
5. Section of cuticle in area not provided with setae. *pp* small processes, *h* hypodermal layer.
6. Section through a socket highly magnified. *s* external opening of socket, *n* small nucleus or darkly staining body, *sc* special cell.
7. Magnified view of small part of one of the setae.

The magnifications vary. The diameter of the setae is about ·0023 mm. The thickest part of the chitin and hypoderm in fig. 4 is ·01 mm.



H. Eltringham del.

AN ORGAN IN THE HIND WING OF MYRMELEON NOSTRAS ?

ON MICRO-LEPIDOPTERA FROM THE GALAPAGOS ISLANDS AND RAPA

By Edward Meyrick, B.A., F.R.S.

[Read June 2nd, 1926.]

The Micro-Lepidoptera collected by Mr. C. L. Collenette and Miss C. E. Longfield in these islands in the course of the *St. George* Expedition, 1924–5, have been submitted to me for study by the authorities of the British Museum, in which the types are deposited. There is no relation between the two localities, and I will treat them separately.

Rapa Island.

The following particulars of the island of Rapa (also known as Oparu) are extracted from an article on its Flora by Mr. L. A. M. Riley in the Bulletin of Miscellaneous Information, no. 2 (1926), issued by the Royal Botanic Gardens, Kew.

Rapa is situated in 27° 36 S., 144° 17 W., and is five miles in length by four in breadth. It is of volcanic origin with steep jagged peaks, of which the highest rises to 2077 feet. In shape it resembles a misshapen C, thickened towards the north and south, with the interior occupied by Ahurei Bay, which fills the bed of an ancient crater, and opens to the sea on the eastern side. It is little visited by vessels (Mr. Collenette thinks perhaps one or two small trading schooners a year). There is a native population, which cultivates the taro (*Colocasia*), orange, lime, candle-nut (*Aleurites*), *Ricinus*, *Hibiscus*, etc. The greater part of the hill slopes are clothed with short grass and fern. Thick vegetation clothes some of the higher peaks, the sheltered and damp gullies down to sea-level, and the slopes of detritus at the foot of cliffs. At about 500 feet a tree-fern makes an appearance, becoming more plentiful as the elevation increases, and eventually completely dominating all other trees. Amongst 17 plants collected 4 were new to science, the latter including a species of *Corokia*, a genus previously known only from New Zealand and the Chatham Islands, which are distant 2000 miles, without intervening islands.

The species of Micro-Lepidoptera obtained numbered 17; of these 3 are apodemic, and these are undoubtedly all of artificial introduction, and easily accounted for; the remaining 14 are endemic, and suggest considerations of great interest.

To appreciate the remoteness of this little island reference should be made to a map; associated with it at some distance are the much smaller Marotiri and the Neilson rock or reef; otherwise the next neighbours are the Austral group, the nearest 250 miles distant, but these are also mere scattered specks, and the Cook group at 800 miles no better; Samoa (small) is 1600 miles, Fiji (of fair size) 2000, the Australian coast 3000.

The visit lasted only 8 days in April, and the Micro-Lepidoptera were all collected at light either at low levels or at 800 feet. Mr. Collenette and Miss Longfield were not collecting Micro-Lepidoptera only, but had other interests. Considering these circumstances and the nature of the island, I think anyone conversant with the difficulties of practical Micro-collecting will admit that the species obtained would probably not be more than a fourth of the actual

fauna, which might need two years' steady work to exhaust it. How could this fauna have originated? These fragile little insects have no powers of independent flight, and are quite at the mercy of the wind; but supposing them capable of being carried 2000 miles over the ocean without perishing, what chance would they have of hitting on an island of this size? The answer is about 1 in 3000, and moreover the individual would have to be an impregnated female, and the island would have to contain the appropriate food-plant. The risk is practically prohibitive, even in long periods of geological time.

Let us now consider the actual endemic fauna. It consists of 7 genera, as follows:—

Dichelopa is represented by no less than 6 species; there are 6 others in Eastern Australia, and none elsewhere. Between these settlements of the genus lies Fiji, where there are resident entomologists from whom I have received a number of species of Micro-Lepidoptera, but not a single example of *Dichelopa*, nor indeed of any genus at all allied to it.* The Australian species are all very similar; the Rapa species show very much greater diversity of superficial characters (the same structural variations occur in both groups), but one of them is very similar to the Australian; this should naturally be taken to indicate that the Rapa stock is the original one, and the Australian a colony from it. It should be remembered that whilst a wind-borne insect from Australia might have small chance of striking an island, an islander might have quite a fair chance of striking Australia. As the facts with regard to this genus are so unexpected, it may be well to add that it possesses an unusual combination of characters which renders it easily and certainly identifiable. I should anticipate that Rapa will be found to possess probably 20 species or more of this particular genus.

Gracilaria has 2 species; this large and characteristic genus is universally distributed in all regions, including New Zealand and Hawaii, but is only known in Fiji at present by two introduced species. The closely related *Timodora* (only technically distinct) inhabits Fiji, Tonga, and Queensland. The Rapa species are of typical character, and such as might have occurred in any other area. The universal range of *Gracilaria* is in itself a striking and unusual phenomenon, accentuated by the present discovery; it at least proves the genus, though highly specialised, to be very old.

Decadarchis has 2 species; it is a genus of over 30 species, distributed through Polynesia, N.E. Australia, the Malay Islands, and India, to the Seychelles. The larvae feed on dry vegetable refuse and dead wood, and can therefore find sustenance anywhere. The genus is one of a considerable group of genera with similar larval habits, which has its maximum development in Australia, New Zealand, and Polynesia; all Polynesian islands contain examples of this group.

Spilonota has one species; there are about 50 in all, of which more than half belong to Australia and New Zealand, and there are also endemic species in Fiji and the Kermadecs; a few are found in India, but in other regions only stragglers.

Cosmopteryx has one species; this large genus of fragile and beautiful insects is very widely spread but more numerous within the tropics, and does not reach New Zealand; Fiji has 3 endemic species.

* Since this was written, I have received for study about 120 species of Micro-Lepidoptera from Samoa, which also do not include a single *Dichelopa* nor anything approaching it.

Ulochora has one species; the only other species of the genus is found in Fiji. From the known habits of allied genera it is probable that the larva feeds on dry vegetable refuse.

Nesoscopa is at present endemic; I judge it to have some relation to *Harmologa miserana*, a species occurring in Java and E. Australia, which it resembles both structurally and superficially.

The Micro-Lepidoptera found in islands have commonly a strong tendency to belong to refuse-feeding genera, because their food is always forthcoming; *Decadarchis* and *Ulochora* are such genera, and there will undoubtedly prove to be other genera in Rapa allied to these, but the other 11 species all belong to undoubted leaf-feeding genera, and would require proper food-plants to suit their tastes.

I am satisfied that the extent and character of this endemic fauna postulates former conditions very different from those now existing, viz. a much larger land-area, and a greatly improved connection with the Fijian and Australian regions. A rise of 12,000 feet in the sea-bottom of the South Pacific is required to show these results, but I entertain no doubt that such an elevation must have existed since the Eocene period, because it is absolutely the only explanation possible. Such a rise would (as shown in the recent "Times Survey Atlas of the World") convert Rapa into an elongate island some 400 miles in length, with a group of large islands to the northward, and a chain of smaller ones leading to the greatly enlarged Fijian land-area. In a direct line between Rapa and New Zealand deeper waters prevail, and no improved access would be given that way. Such a conformation of land and sea would be favourable for the development in Rapa of a peculiar fauna of Fijian and Australian origin such as is actually found there.

The three introduced species are discussed in their places.

List of Species.

TORTRICIDAE.

Nesoscopa, n. g.

Palpi long, porrected, second joint rough-scaled towards apex above and beneath, terminal joint rather long, obtuse. Antennae ♂ fasciculate-ciliated. Thorax without crest. Fore-wings 2 from ⅔, 3-5 approximated from near angle, 7 separate, to termen. Hind-wings without cubital pecten; 2 from rather near angle, 3-5 rather approximated towards base, 6 and 7 nearly approximated at base.

Allied to *Harmologa*. The position of vein 2 of hind-wings is characteristic and distinctive.

Nesoscopa exsors, n. sp.

♂. 15-16 mm. Head, thorax whitish-grey. Palpi whitish, second joint suffused grey towards apex. Uncus broad, narrowed towards apex, with two short apical hooks. Fore-wings suboblong, costa gently arched, termen rounded, somewhat oblique; light grey, more or less mixed white, the grey colour tending to form irregular transverse striae and strigulae; several irregular curved oblique transverse blackish striae, one near base, one forming edge of basal patch, one forming anterior edge of central fascia, and two or three others irregular and incomplete posteriorly, a series of dark fuscous marginal dots round apex and termen: cilia white barred grey. Hind-wings whitish-grey; cilia white.

At 800 feet; 3 ex.

Dichelopa honoranda, n. sp.

♂. 12 mm. Head, palpi, thorax, abdomen grey. Fore-wings elongate, termen obliquely rounded; white; basal patch with straight oblique edge, moderate oblique central fascia, and moderate somewhat irregular fascia from costa before apex to tornus light grey edged by black striae margined on each side ferruginous-ochreous: cilia whitish-grey. Hind-wings 3 and 4 coincident; light grey suffused white on basal half; cilia whitish, a pale greyish subbasal shade.

At 800 feet; 1 ex.

Dichelopa sericopis, n. sp.

♀. 13–16 mm. Head whitish-ochreous. Palpi pale ochreous. Thorax pale ochreous anteriorly suffused grey. Ovipositor long, slender, apex simple, rounded. Fore-wings suboblong, termen obliquely rounded; light greyish-ochreous sprinkled grey, sometimes greyer-tinged, a few scattered grey strigulae sometimes suffused ochreous, margins more or less closely and regularly strigulated or dotted grey or dark fuscous throughout; origin of rather broad central fascia sometimes indicated on costa by grey suffusion: cilia pale ochreous. Hind-wings 3 and 4 coincident; white; a triangular grey apical patch occupying $\frac{1}{3}$ of wing, narrowly extended on termen to below middle; cilia white, basal third grey on grey area.

At low level and 800 feet; 12 ex. The fact that these are all females may indicate that the collectors were late for the species.

Dichelopa deltozancla, n. sp.

♂. 13 mm., ♀ 15–18 mm. Head, thorax whitish-grey. Palpi grey, apex whitish. Abdomen grey, anal tuft ♂ white; uncus triangularly dilated transversely towards apex; ovipositor transversely broad, apex bilobed. Fore-wings elongate, termen obliquely rounded; light grey, scattered dark fuscous strigulae on margins; basal patch and rather broad oblique central fascia somewhat darker, containing some dark strigulae and limited by slightly curved nearly parallel dark fuscous striae or series of strigulae, costal half of central fascia in ♂ suffused dark grey; apical area with two or three irregular series of dark grey strigulae: cilia whitish-grey. Hind-wings 3 and 4 coincident; white; a triangular grey apical patch occupying $\frac{2}{5}$ of wing, ♂ extended on termen to below middle, ♀ continued as a cloudy terminal fascia to tornus; cilia whitish-grey, ♂ white round dorsum and tornus.

At 800 feet; 3 ex. The form of the uncus is unique, the broadest part (or base of the triangle) being at the apex. The ♀ is taken as the type, since it is possible that the single ♂ may belong properly to the preceding species; in this sex the ovipositor affords a good distinction.

Dichelopa ceramocausta, n. sp.

♀. 13–15 mm. Head, palpi, thorax dark brown. Ovipositor moderately broad, constricted towards apex, with two long apical lobes. Fore-wings suboblong, costa moderately arched anteriorly, then straight, termen slightly rounded, somewhat oblique; dark purplish-brown; anterior edge of straight oblique central fascia partially indicated by dark fuscous suffusion; a small transverse dark fuscous spot towards termen in middle; costal edge interruptedly pale ochreous from before middle to apex: cilia pale ochreous, basal half suffused dark brown. Hind-wings 3 and 4 coincident; dark grey; cilia light grey, becoming ochreous-whitish round apex, a grey subbasal shade.

At low level; 3 ex.

Dichelopa iochorda, n. sp.

♂. 17 mm. Head whitish-ochreous, face fuscous. Palpi brown. Thorax violet-brown. Fore-wings suboblong, costa anteriorly moderately arched, termen somewhat rounded, rather oblique; purple-bronzy-brownish, suffused darker and more purplish towards costa; slender oblique parallel ochreous-whitish fasciae suffused ferruginous at extremities and on edges from before $\frac{1}{3}$ of costa to middle of dorsum, and from beyond middle of costa to tornus; small undefined spots of ochreous suffusion round posterior part of costa and termen: cilia light greyish-ochreous, suffused grey towards base. Hind-wings 3 and 4 short-stalked; grey, cilia whitish, base grey.

At 800 feet; 1 ex.

Dichelopa exulcerata, n. sp.

♂. 26–30 mm. Head, thorax light brownish, sometimes spotted dark fuscous. Palpi ochreous-whitish, partially suffused brownish laterally. Fore-wings suboblong, costa anteriorly moderately arched, then straight, termen slightly rounded, rather oblique; greyish-ochreous mottled light brownish; a series of small dark fuscous spots along costa; markings formed of dark brown suffusion and marbling sprinkled blackish dots, viz. a very undefined basal patch, a rather broad very irregular-edged oblique central fascia, and flattened-triangular costal patch; some of the black dots touched with ferruginous-brown: cilia pale brownish, basal half barred fuscous. Hind-wings 3 and 4 short-stalked: rather dark grey; cilia whitish-grey, a grey subbasal shade.

At 800 feet; 3 ex.

EUCOSMIDAE.

Spilonota thyellopis, n. sp.

♂. 20 mm. Head grey, a strong conical frontal tuft. Palpi dark grey, second joint with brown supramedian bar. Antennal notch at about $\frac{1}{5}$ (apex broken), scape elongate. Thorax grey, shoulders and posterior margin dark grey. Fore-wings elongate, a broad costal fold from base to middle (enclosing a tuft of long white hairs), termen nearly straight, somewhat oblique; grey mixed ferruginous-brown; costal fold grey with strong transverse blackish strigulae; blackish-fuscous quadrate blotches, connected above with blackish strigulae, on dorsum near base and before middle, and an outwards-oblique rhomboidal blotch towards tornus; an irregular patch of blackish-fuscous suffusion in disc beyond middle; posterior half of costa suffused dark fuscous, with four pairs of whitish strigulae; an irregular dark fuscous blotch towards termen above middle; some dark fuscous strigulation, and white speckling before termen: cilia dark grey. Hind-wings grey; cilia whitish-grey, a grey subbasal shade.

At 800 feet; 1 ex. This is doubtless attached to a Myrtaceous shrub, as customary.

Crocidosema plebeiana, Zell.

At low level; 1 ex. This species, probably South American in origin, is now spread through a great part of the world, including Australia and several (probably nearly all) of the Pacific islands; it is unquestionably introduced with the *Hibiscus*, on which (and allied genera) it feeds.

Argyroploce aprobola, Meyr.

At low level; 8 ex. Originally described from Tonga, but now known to occur in Australia and throughout the Indo-Malayan region to the Sey-

chelles; probably Indian in origin. The larva feeds on a number of cultivated trees and shrubs, including *Mangifera*, *Nephelium*, *Cassia*, *Cinnamomum*, *Lantana*, etc., and is therefore readily imported with any of these.

Gelechiadae.

Stoeberhinus testacea, Butl.

At low level; 1 ex. A proper Polynesian insect, recorded from Fiji, the Marquesas, and Hawaii, and doubtless spread generally through the islands, but not known elsewhere; the larva feeds on dry vegetable refuse, and is probably carried about by the natives in their canoes.

Cosmopterygidae.

Cosmopteryx aphranassa, n. sp.

♂. 9 mm. Head, thorax dark fuscous, three fine white lines, face pale bronzy. Palpi dark fuscous lined white. Antennae blackish ringed white, apical area with 1 apical joint white, then 3 black, 1 white, 3 black, 1 white. Abdomen ochreous-grey. Fore-wings apex caudate; rather dark grey; a fine white blackish-edged suboblique line from base beneath costa to near band, one median from $\frac{1}{4}$ of wing to near band (the usual third line apparently very short, obliterated, or absent); a light ochreous-yellow postmedian band, broad on costa and with costal edge white, narrowed downwards and on dorsum only half costal width, edged on both sides by white streaks, anterior oblique, followed by a minute black dot on fold, posterior with extremities silvery and preceded by black dots, lower somewhat anterior; a white line from near beyond this along termen to apex: cilia ochreous-whitish. Hind-wings white; cilia ochreous-whitish.

At low level and 800 feet; 2 ex. Peculiarly characterised by the white hind-wings.

Ulochora perfuga, n. sp.

♂ ♀. 12–13 mm. Head pearly-whitish, crown greyish-tinged. Palpi slender, whitish. Antennae whitish dotted dark fuscous. Thorax pale grey, apical half of tegulae whitish. Fore-wings grey or fuscous, somewhat whitish-suffused towards base of costa; some undefined elongate dark fuscous suffusion extending from end of cell to near apex, and also some along termen from tornus: cilia dark grey, becoming whitish towards tips. Hind-wings and cilia grey.

At low level; 3 ex., in poor condition.

Gracilariadae.

Gracilaria hilaropis, n. sp.

♂ ♀. 12–13 mm. Head ochreous-white, crown more or less suffused purple-grey. Palpi smooth, ochreous-white, tip grey. Thorax purple-grey. Fore-wings deep fuscous-purple, dorsum mottled dark grey, sometimes dotted light yellowish suffusion between the dark mottling, or dorsal area wholly pale yellow transversely strigulated purple-fuscous; an irregular oblique yellow blotch near base not reaching margins; a somewhat irregular-edged triangular brassy-yellow blotch extending on costa from beyond $\frac{1}{4}$ to $\frac{3}{5}$, and reaching $\frac{3}{4}$ across wing; an irregular-oval brassy-yellow blotch almost or quite resting on costa about $\frac{3}{4}$: cilia dark

grey. Hind-wings dark grey; cilia grey. Middle femora and tibiae dark purple-fuscous, tarsi whitish.

At 800 feet; 3 ex.

Gracilaria crypsidelta, n. sp.

♂. 13 mm. (Head missing.) Fore-wings dark purple-fuscous, mottled somewhat lighter fuscous on margins; an obscure triangular blotch extending over median third of costa and reaching $\frac{2}{3}$ across wing, indicated by very minute transverse pale brassy-yellowish striation formed of scale-tips, its anterior angle suffused whitish-ochreous on costa: cilia fuscous. Hind-wings rather dark grey; cilia grey. Middle femora and tibiae dark purple-fuscous, tarsi whitish.

At low level; 1 ex.

LYONETIADAE.

Decadarchis pelotricha, n. sp.

♂. 15–16 mm. Head grey-whitish. Palpi grey, joints white towards base, densely tufted with white hairs, terminal joint with long expansible grey apical tuft. Thorax whitish suffused grey anteriorly. Fore-wings whitish; short grey marks from costa at $\frac{1}{3}$ and middle; some irregular mottling of dark grey scales in disc, becoming stronger posteriorly and forming variable irregular elongate blotches, and more distinct elongate streaks above and below apex terminating in a round black apical spot; dark fuscous lines along costa posteriorly and termen: cilia white, with entire dark fuscous postmedian and apical lines. Hind-wings 5 and 6 stalked; grey-whitish, greyer posteriorly; a pencil of long light greyish-ochreous hairs extending along costa from base to $\frac{2}{3}$, beneath this some short white hairs; cilia whitish.

At 800 feet; 3 ex.

Decadarchis sphenacma, n. sp.

♂ ♀. 15–26 mm. Head ochreous-whitish. Palpi grey-whitish, second and terminal joints densely tufted with white hairs. Thorax white or grey-whitish. Fore-wings white, partially tinged whitish-ochreous, sometimes a dorsal streak of greyish suffusion; extreme costal edge dark fuscous towards base; a small dark fuscous elongate mark on middle of costa; margins of cell posteriorly slightly speckled dark fuscous; a fine line of blackish speckling between veins 5 and 7 (6 absent as usual) to apex, forming a short strong projecting black bar at apex; a few blackish specks on terminal edge: cilia white, some dark fuscous and blackish speckling, especially at apex beyond bar. Hind-wings 5 and 6 stalked; light grey, tinged whitish towards termen; cilia grey-whitish, round apex white.

At low level; 4 ex.

GALAPAGOS ISLANDS.

These islands lie on the Equator at a distance of about 500 miles from the Pacific coast of South America. Though not individually large, they are rather numerous and cover a not inconsiderable space; they have therefore a fair chance of intercepting insects blown out to sea, and are open to the whole broadside of the continent, nor is 500 miles too far for even fragile insects to be carried safely; there is no other land within reach of them, and it is therefore reasonable to expect that they would possess a fair fauna of exclusively American type. This expectation is fulfilled, as of the 11 species

in recognisable condition (there are 2 specimens not determinable) one is a common American insect which may perhaps have been introduced by man, and the other 10 are apparently peculiar endemic forms of American genera. None show any affinity to recognised Polynesian genera.

List of Species.

Pterophoridae.

Trichoptilus derelictus, n. sp.

♂. 13 mm. Fore-wings rather dark brown, becoming dark fuscous on posterior half; a very fine blackish linear mark in disc towards cleft; a short white dash on costal edge beyond cleft; fasciae of white irroration crossing both segments at $\frac{1}{3}$ and $\frac{2}{3}$; some white scales at apex: cilia grey, mixed white at both fasciae and suffused white at apex of both segments, some black scales irregularly strewn between these. Hind-wings fuscous irrorated dark fuscous; cilia light fuscous, on dorsum of third segment a minute tooth of one or two blackish scales at $\frac{3}{5}$.

Charles Island, July; 1 ex.

Pterophorus nephogenes, n. sp.

♂. 18–19 mm. Head, palpi, thorax white irrorated dark fuscous. Fore-wings cleft to before $\frac{3}{4}$, first segment rather narrow, pointed, second rather broad; fuscous irrorated white, and sprinkled dark fuscous; costal edge suffused dark fuscous from base to beyond cleft; a small spot of white suffusion on fold at $\frac{1}{3}$, accompanied by a few black scales; a suffused white dot at base of cleft, preceded by a few black scales; a slight median streak of dark suffusion in first segment: cilia pale greyish, partially suffused or barred white, some indistinct dark fuscous basal dots. Hind-wings grey; cilia light grey.

Albemarle and Charles Islands, July, August; 5 ex. Perhaps allied to *eupatorii*.

Tortricidae.

Platynota colobota, n. sp.

♂. 13 mm. Head, palpi, thorax dark fuscous. Fore-wings rather elongate, dilated, costa with narrow fold from base to beyond middle, termen rather oblique; 10 absent (coincident with 11); brown suffused fuscous, costa suffused darker fuscous; indistinct scattered transverse strigulae of dark fuscous irroration, especially towards costa posteriorly: cilia fuscous. Hind-wings grey, paler and ochreous-tinged towards base; cilia grey.

Albemarle Island, July; 1 ex. The specimen is in indifferent condition, but is recognisable by structure; it possesses the frontal ridge, stalked veins 7 and 8 of fore-wings, and anastomosis of 8 with cell before middle in hind-wings as in the type of *Platynota*, and agrees closely in the other details of neuration; it can thus be identified with the genus without regarding the loss of vein 10.

Eucosmidae.

Crocidosema synneurota, n. sp.

♂ ♀. 11–12 mm. Fore-wings 3 and 4 coincident towards apex; costal fold of ♂ extending to $\frac{1}{2}$, tufted with rough scales externally; pale brownish, costa with

strong oblique dark fuscous strigulae, a small round blackish apical spot; basal patch represented by a quadrate dark brown antemedian dorsal blotch; an irregular triangular dark brown praetornal blotch; ocellus pale, edged anteriorly by a leaden streak, containing three short linear blackish marks, some dark brown suffusion and black scales above this. Hind-wings grey; basal tuft in ♂ as in *plebeiana*.

Albemarle and Indefatigable Islands, July, August; 3 ex. (1 ♂, 2 ♀). These are all in damaged condition, and the above description is incomplete, but sufficient to distinguish the species; the neural peculiarity of veins 3 and 4 of fore-wings is constant in all the specimens, and is not shown in any examples of *plebeiana* that I have examined; the well-defined blackish apical spot also catches the eye.

GELECHIADAE.

Aristotelia naxia, n. sp.

♂. 11 mm. Head, thorax grey. Palpi whitish, second joint with two blackish bands (terminal broken). Fore-wings grey irrorated white; markings blackish edged white suffusion; a slender entire oblique transverse streak at $\frac{1}{6}$; an oblique fasciate streak from costa at $\frac{1}{3}$ to fold, from its apex a lobe projecting obliquely upward to middle of disc, tipped by black first discal stigma, this streak terminated beneath by a brownish-ochreous thick longitudinal subdorsal streak nearly reaching postmedian fascia; a transverse fascia at $\frac{2}{3}$, narrowed in disc and interrupted with brownish-ochreous beneath black second discal stigma; an inwards-oblique triangular blotch from costa before apex. Hind-wings and cilia grey; an expansible grey-whitish hairpencil from base of costa.

Charles Island, July; 1 ex. Apparently nearest *vicana*; the specimen is imperfect, but the oblique subbasal streak reaching dorsum, and the hairpencil of hind-wings are distinguishing characters.

Gelechia protozona, n. sp.

♂ ♀. 13–15 mm. Head whitish or ochreous-whitish. Palpi whitish, second joint with scales little rough beneath, basal half and a subapical ring suffused dark fuscous, terminal joint with three dark fuscous bands. Thorax dark purplish-fuscous. Abdomen light ochreous-yellowish, segmental margins suffused grey. Fore-wings dark purplish-fuscous; a direct white entire fascia at $\frac{1}{4}$; white transverse spots on costa at middle and $\frac{3}{4}$, a triangular spot on dorsum rather beyond first of these, and sometimes one or two white scales at tornus opposite second: cilia grey, some white suffusion beneath apex. Hind-wings over 1, apex obtuse, termen hardly sinuate; light grey; cilia pale greyish-ochreous.

Albemarle Island, August; 3 ex. Allied to *cercerella*.

Gelechia gnathodoxa, n. sp.

♀. 10 mm. Head white. Palpi white, second joint with basal half and an imperfect subapical ring dark fuscous, terminal joint with median and subapical blackish rings. Thorax blackish. Fore-wings blackish; a moderate white transverse fascia at $\frac{1}{6}$, connected by a strong irregular-edged dorsal streak with a triangular white spot at $\frac{3}{4}$ of dorsum reaching half across wing, this connected by a fine line with a white tornal spot; white spots on costa at middle and $\frac{4}{5}$, latter opposite tornal: cilia ochreous-whitish, on costa grey. Hind-wings over 1, termen hardly sinuate; grey; cilia white.

James Island, July; 1 ex. Allied to preceding.

BLASTOBASIDAE.

Blastobasis crotospila, n. sp.

♂. 10 mm. Head grey-whitish. Palpi grey, terminal joint as long as second, moderate, pointed. Antennae with moderate subbasal notch. Thorax grey-whitish, anterior margin suffused dark grey. Fore-wings grey speckled whitish; a dark fuscous elongate mark on costa above plical stigma; stigmata moderate, dark fuscous, plical obliquely before first discal, an additional dot beneath and slightly before second discal, these two connected with costa and dorsum respectively by cloudy rather dark grey opposite spots: cilia pale grey. Hind-wings grey; cilia pale grey.

James Island, July; 1 ex. Nearest the Brazilian *commendata*.

HYPONOMEUTIDAE.

Atteva hysginiella, Wall.

Albemarle, James, and Indefatigable Islands, up to 600 feet, July; 23 ex. Described by Wallengren as being from Panama, but I am not aware that the occurrence of this striking insect on the American continent has ever been confirmed, and am strongly of opinion that the record of locality is erroneous; under the name of *sylpharis* it was described by Butler from the Galapagos, which is evidently its real home in any case.

Atteva monerythra, n. sp.

♀. 26–28 mm. Head dark indigo-blue, sides of crown, two spots on forehead and two on lower edge of face pale yellow. Palpi blackish, white posteriorly and towards base of joints. Thorax dark indigo-blue, collar on sides towards tips, and two posterior stripes sometimes connected by bar pale yellow. Abdomen blue-blackish, a lateral stripe and ventral series of blotches yellowish-white. Anterior coxae orange in front. Fore-wings dark indigo-green; markings pale yellow, viz. a streak below costa from near base to $\frac{4}{5}$ variably interrupted into spots or dots, an irregular streak in disc from $\frac{1}{3}$ to $\frac{2}{3}$, a submedian streak from near base to $\frac{4}{5}$, a subdorsal streak (dorsal near base) to middle or $\frac{3}{4}$, an irregular spot towards apex, and a group of dots before lower half of termen; a small red spot beneath costa at $\frac{2}{3}$; several variably connected white dots along costa towards apex: cilia white, basal half dark fuscous. Hind-wings subhyaline white, tinged grey on posterior half, veins on posterior half and a terminal fascia becoming broader towards apex dark fuscous; cilia white, basal half dark fuscous on termen.

Charles Island, July; 3 ex. Closely related to *hysginiella*, but larger and immediately distinguished by the absence of the antemedian and tornal red spots of that species, in which also the anterior half of hind-wings and dorsal cilia are tinged grey. Charles Island is small and about 40 miles distant from the three given above as localities for *hysginiella*, which are relatively larger and about 15 miles distant from each other; hence it appears that *monerythra* may be supposed to be a descendant of *hysginiella* modified in isolation.

TINEIDAE.

Xylesthia pruniramiella, Clem.

James Island, July; 2 ex. These do not seem to differ appreciably from continental examples; the larva feeds in dead wood of various trees, and might perhaps be introduced in drift wood or by man.

ON SOME AUSTRALIAN COLEOPTERA COLLECTED BY CHARLES DARWIN DURING THE VOYAGE OF THE "BEAGLE"

By ARTHUR M. LEA.

[Read June 2nd, 1926.]

THE British Museum having at various times sent to me for identification specimens taken by Darwin, mixed with others, I suggested to Mr. Arrow that it appeared desirable to identify all the remaining Australian beetles taken by the great naturalist and deposited in that institution. To this he agreed and they were sent to Adelaide in 1921, but, owing to a long absence from Australia and other unforeseen circumstances, I was unable to finish dealing with them till early in 1926. The specimens sent were all small, and in fact Mr. Arrow wrote :—

"Darwin did not give his collection to the Museum, but allowed different individuals to take particular groups which interested them, and the unsorted mass of minute specimens was given to G. R. Waterhouse, only coming here in 1887."

In addition to the specimens taken by Darwin, I have, when some of the same species were available, noted those from several Australian collections; but, unless expressly stated to the contrary, types of all the new species have been returned to the British Museum.

A few specimens were in such bad condition that they could not be identified with certainty, or it was inadvisable to make them into types; these were passed over without comment.

List of Species.

CARABIDAE.

Bradycellus promtus, Er. Hobart.

HYDROPHILIDAE.

Ochthebius macrognathus, n. sp.

♂. Black with a slight metallic gloss and extremely short, ashen pubescence, legs reddish, scape flavous.

Head with two longitudinal impressions, a small shining tubercle near each eye, these very prominent; punctures rather dense but partially concealed. Mandibles strongly projecting, inner edge straight, outer arched, concave above and convex below. Scape slightly curved and slightly longer than the rest of antenna. Prothorax strongly transverse, sides strongly rounded in front, and arcuate to base, with five longitudinal impressions; punctures dense, but in places partly concealed. Elytra at base scarcely wider than widest part of prothorax, slightly dilated to beyond the middle and then narrowed to apex, a shallow depression near the suture at the basal third; with fairly large punctures in sharp striae; interstices flat, wider than seriate punctures, with crowded and minute punctures. Length, 2–2·25 mm.

♀. Differs in having the eyes less prominent, the jaws not projecting, and the legs somewhat thinner.

Hab.—Tasmania : Hobart.

The prominent jaws of the male, the exserted parts of which are about as long as the eyes, render this species very distinct from the three Australian species named by Blackburn (*O. australis*, *brisbanensis*, and *novicius*). Most of the upper surface is subopaque, the metallic gloss is coppery, or coppery-red, or greenish; the middle of the metasternum and the tip of the abdomen are highly polished, the rest of the under surface is opaque. The median impression of the pronotum is continuous from base to apex, but is distinctly narrowed in the middle, more strongly on some specimens than on others; the impression on each side of it is slightly curved, and is usually interrupted near the base; the outer one on each side is shorter than the others, owing to the arcuation of the sides near the base; in addition there appears to be a feeble impression close to the antero-lateral margin. Specimens of the species were also taken by Mr. H. H. D. Griffith on Mount Wellington.

Five specimens from New South Wales (Goobang, Macleay Museum, and Sydney, *A. M. Lea*), differ in being somewhat larger (up to 3 mm.), with still more prominent jaws in the male (the exserted parts being decidedly longer than the eyes), the constriction in the median groove of the pronotum more pronounced; but these features do not appear to be of more than varietal importance.

Hydrochus serricollis, Lea. Launceston.
Paracymus lindi, Blackb. Sydney.

SILPHIDAE.

Clambus australiae, n. sp.

Black, under surface of head, antennae and most of legs of a more or less dingy pale brown. Upper surface glabrous, under surface minutely pubescent.

Prothorax and elytra finely shagreened and with numerous small punctures, a very fine stria on each side of suture. Metasternum opaque, abdomen shining. Length, 1 mm.

Hab.—Western Australia : King George's Sound (*C. Darwin*); cotype in British Museum. South Australia : Ooldea (*A. M. Lea*). Type, I. 15984, in South Australian Museum.

Slightly larger than *C. simsoni*, from Tasmania, but intensely black and with dingier legs; *C. tierensis*, also from Tasmania, is somewhat similarly coloured, except that the sides of the prothorax are usually pale, but it is a conspicuously larger species, with the sutural striae quite distinct under a lens. The elytral punctures and striae are here scarcely visible under a lens, and the shagreening not at all, but under a microscope they are sufficiently distinct.

SCAPHIDIIDAE.

Scaphisoma instabile, n. sp.

Blackish, apex of elytra (but not extreme apex) flavous, legs and antennae more or less reddish.

Antennae long and thin, eighth joint decidedly smaller than the preceding and the three following ones. Prothorax apparently impunctate. Elytra with a narrow stria on each side of the suture; punctures very minute. Length, 1·5 mm.

Hab.—Tasmania : Hobart.

In addition to two specimens taken by Darwin, there are under examination twenty others taken by myself from Tasmania (Anon River, Chudleigh and Devonport), New South Wales (Sydney) and Western Australia (Mount Barker and Bridgetown). Many of these are coloured as the type, except that the pale apical part varies, it usually appears as a subapical fascia (narrowly interrupted at the suture) with the tips infuscate, or the infuscations may appear as two transverse unequal spots on each elytron; on some specimens the flavous parts appear as two transverse subapical spots, narrowed towards but not touching the suture, and dilated to the sides, where each occupies about one-fourth of the length of the elytron. The general colour, however, varies, till some specimens are of a bright pale castaneous, with the apical part of the elytra almost white, the tips just perceptibly infuscate. Two Tasmanian specimens are bright castaneous, with the pronotum dark brown (its base and apex narrowly bright castaneous), and the flavous apex occupying almost one-third of the elytra. The elytral punctures are sparse and very minute; under a lens of 12 diameter power they are just visible from certain directions. The species is the size of *S. bryophagum*, but not uniformly red, and the antennae are longer and thinner. The colours of some specimens approach those of *S. novicum*, but the pale tips of the elytra cover a greater amount of surface, and the size is decidedly less.

PHALACRIDAE.

Phalacrus corruscans, Panz. King George's Sound.
Litochrus sydneyensis, Blackb. King George's Sound.

LATHRIDIIDAE.

Corticaria australis, Blackb. Sydney.

DERMESTIDAE.

Anthrenus ocellifer, Blackb. Hobart.

SCARABAEIDAE.

Automolus humilis, Blanch. Sydney.

BUPRESTIDAE.

Germarica lilliputana, Thoms. Sydney.
Cisseis puella, Kerr. Sydney.

DASCILLIDAE.

Cyphon fenestratus, Blackb. King George's Sound.

MALACODERMIDAE.

Laius cinctus, Redt. Sydney.
Hypattalus abdominalis, Er. Hobart.

Ptinidae.

Dryophilodes squalidus, n. sp.

Black, antennae and legs obscurely diluted with red. Moderately clothed with dingy, subdepressed pubescence.

Antennae moderately long. Prothorax moderately transverse, sides (as viewed from above) rather acutely produced in middle and arcuate towards base, hind angles acute; with crowded punctures somewhat larger than on head. Elytra distinctly wider than prothorax, parallel-sided to near apex; with crowded and rather small punctures, somewhat stronger near base than elsewhere, and nowhere seriate in arrangement. Length, 3·25–3·75 mm.

Hab.—Tasmania : Hobart.

One specimen was taken by Darwin, other specimens before me are from Hobart and Mount Wellington (*A. M. Lea*), and Adelaide (*Rev. T. Blackburn*). On one Hobart and one Adelaide specimen the elytra are very obscurely diluted with red posteriorly, on the one taken by Darwin the elytra are entirely black, all three have the apex of prothorax obscurely reddish, the specimen from Mount Wellington is entirely of a dull brown, the legs and abdomen somewhat paler than the other parts; one Adelaide specimen, probably immature, is still paler, with the abdomen almost flavous.

Dryophilodes angustus, n. sp.

Dull reddish-castaneous, sterna infuscate. Clothed with very short, pale, depressed pubescence.

Head with small crowded punctures. Eyes small and prominent. Antennae long and thin. Prothorax scarcely wider than long, sides moderately rounded, hind angles more than 90°, a vague depression on each side of middle near base; punctures as on head. Elytra long, narrow, and parallel-sided, with crowded and small punctures; in addition towards the base with inconspicuous rows of larger ones, that vanish before the middle. Length, 1·75 mm.

Hab.—Tasmania : Hobart.

A single specimen was obtained. From above, its head appears to be entirely concealed, but the outer edges of the eyes are just visible; the seriate arrangement of the elytral punctures is rather faint.

A specimen recently taken on Cradle Mountain (Tasmania) appears to belong to the species, but differs from the type in being darker, with the head, scutellum, basal two-thirds of prothorax and most of the under surface, black; the prothorax is also somewhat wider, with its middle slightly wider than the elytra, instead of the same width; it is probably a male, and the type is probably a female.

Curculionidae.

Encosmia ventralis, n. sp.

♂. Castaneous. Moderately clothed with stramineous and inconspicuous brown scales on upper surface, becoming white on under parts.

Rostrum slightly shorter than prothorax, with fine carinae and almost concealed rows of punctures on basal three-fifths, elsewhere with minute naked punctures. Prothorax about as long as the median width, with crowded punctures. Elytra rather narrow, and parallel-sided to near apex, with rows of large subquadrate punctures, wider than interstices, but in parts slightly obscured. Second

segment of abdomen feebly convex in middle, and shorter than fifth. Length, 1·75–2 mm.

♀. Differs in being somewhat stouter, rostrum slightly longer and thinner, clothed only at extreme base and non-carinate, abdomen rather strongly convex, and second segment along middle the exact length of fifth.

Hab.—Tasmania: Hobart (*C. Darwin*), cotype in British Museum, Strahan in April and Launceston in October (*Aug. Simson*). Type, I. 15987 in South Australian Museum.

In his table of the genera of the Australian Erirhinides Blackburn * noted the abdomen of *Encosmia* as having "Apical ventral segment shorter than second segment." This is decidedly so in the female of the typical species, *E. adelaidae*, and just perceptibly so in the male. In the present species, however, the apical segment is slightly longer than the second in the male, and practically the same length in the female. The present species differs also from *adelaidae* in being consistently smaller, clothing different, legs longer, and rostrum and antennae shorter. It is fairly close to *E. blackburni*, but is much smaller and the two basal segments of abdomen of the male are not concave in the middle: it is still closer to *E. albifascia*, but the scales are narrower and differently arranged on the elytra, the second segment of the abdomen of the female is smaller, and the fifth of the male larger. The scales on the upper surface are so narrow that they appear to be depressed setae rather than true scales; the brownish ones so closely resemble the derm on which they rest that the surface there looks denuded: as a result the elytra appear to have numerous small spots or lines of pale scales, which in places may form interrupted fasciae, but they are easily abraded. At first glance, owing to its denser clothing, the club appears to be slightly darker than the rest of the antenna, but on close examination it is seen to be of the same colour.

Storeus metasternalis, n. sp.

♂. Reddish-castaneous, metasternum blackish. Moderately clothed with fawn-coloured and somewhat darker scales, interspersed with some paler spots, some on sides snowy-white; with short, stiff, semi-erect setae.

Rostrum slightly longer than prothorax, almost straight, parallel-sided; with fine carinae partly concealed by clothing, and continuous to insertion of antennae (about one-fourth from apex), beyond which there are punctures and no clothing. First joint of funicle obtriangular, about as long as three following combined. Prothorax moderately transverse, sides strongly rounded; with dense, partially concealed punctures. Elytra almost parallel-sided to beyond the middle; with rows of large, partially concealed punctures. Intercoxal process of mesosternum sloping, depressed below coxae. Abdomen with well-defined punctures, the two basal segments with a shallow depression, the three median ones slightly arched. Femora stout, unarmed. Length, 3 mm.

Hab.—Tasmania (unique).

An ordinary looking species but easily distinguished by the snowy spots on the sides, and the dark metasternum. In a previously given table of the genus † it could be associated with *S. parvulus*, from which it differs in size, colour, clothing, and parts of the under surface. On the elytra, as seen from above, there are about sixteen pale spots (some rather inconspicuous) of which eight form a V, the junction of which is on the suture at about one-

* Blackb., *Trans. Roy. Soc. S. Aust.*, 1894, p. 148.

† Lea, *Trans. Roy. Soc. S. Aust.*, 1899, p. 187.

third from the apex; between it and the base there are remnants of another V; on each side four snowy spots are conspicuous, one on the prosternum adjacent to the coxa, one on the side of the mesosternum, one on the third interstice from the side, and level with the apex of metasternum, and one on the marginal interstice, level with the apex of the first ventral segment. The interstices are not quite of even width throughout, but are feebly dilated beneath the pale spots. The front of the prosternum is not depressed in the middle, but there is a feeble ridge between each coxa and the apex.

Storeus variabilis, Lea.—An unusually small female, from King George's Sound, appears to belong to this species.

S. brachyderes, Lea. Tasmania.

Cyttalia griseipila, Pasc.—A specimen labelled "Australia," but probably taken in New Zealand.

Epamaebus ziczac, Lea. Hobart.

Orichora trivirgata, Pasc. King George's Sound.

Ethadomorpha clauda, Blackb. King George's Sound.

Desiantha malevolens, Lea. Australia.

Antyllis latipennis, n. sp.

Reddish-castaneous; head, base of rostrum and prothorax (except apex) black. Densely clothed with scales and setae.

Head with dense, normally concealed, punctures. Rostrum rather thin, parallel-sided, slightly curved and slightly longer than prothorax; with dense, partially concealed punctures from base to antennae, in front of these with sparser and smaller but unconcealed punctures. First joint of antenna stouter and slightly longer than second. Prothorax slightly wider than long, base distinctly wider than apex; punctures crowded but normally concealed. Elytra much wider than prothorax, about one-fourth longer than wide. Length, 3 mm.

Hab.—Western Australia: Swan River (unique).

Slightly longer than *A. setosa*, *A. togata*, *A. bella*, and *A. variabilis*, and the elytra decidedly wider in proportion; *A. alternata* is very different, and possibly not even congeneric. The presence of elytral setae distinguishes it from *A. griseola*, and the black parts from *A. aurulenta*, according to description. The sides of the metasternum are somewhat darker than the middle, and the club is slightly darker than the rest of the antenna. The scales on the elytra are of a golden brown, in certain lights and places appearing greyish, although without distinct spots or patches; on the sides and middle of prothorax they are mostly whitish, on the head, under surface and legs they are white. The setae are mostly semi-erect or slightly curved, on the elytra they are confined to a single row on each interstice and are mostly pale; on the prothorax, head and rostrum, they are mostly blackish. The elytral punctures appear through the scales as narrow cuts, much narrower than the striae, but if the scales were removed would probably appear much larger and of different shape. As the two basal segments of its abdomen are slightly depressed in the middle the type is probably a male.

Thechia brevirostris, n. sp.

Dark reddish-brown. Densely clothed with whitish-grey scales; a few short setae at tips of elytra and on legs.

Eyes subelliptic and rather coarsely facetted. Rostrum slightly curved, com-

paratively stout, about thrice the length of the basal width. First joint of funicle not much shorter than the club. Prothorax about as long as the basal width, base feebly trisinuate, sides gently rounded and decreasing in width to apex; with crowded punctures indicated through clothing. Elytra elongate-cordate, apex distinctly notched, interstices even; with rows of large punctures, much wider than interstices, but appearing much smaller through clothing. Two basal segments of abdomen with a wide shallow depression. Legs short, third tarsal joint evenly rounded at apex, and distinctly longer than second. Length (without rostrum), 3 mm.

Hab.—Western Australia : King George's Sound (unique).

Nearer *T. cinerascens* than any other described species of the genus, but much more robust, rostrum decidedly stouter and slightly shorter, and eyes somewhat larger and with larger facets.

Thechia longirostris, n. sp.

Dark reddish-brown. Densely and uniformly clothed with whitish grey scales.

Eyes subelliptic. Rostrum moderately curved and rather long and thin. Two basal joints of antenna not quite the length of club. Prothorax about as long as wide, sides gently rounded, base bisinuate; with crowded punctures, indicated through clothing. Elytra rather narrow, sides parallel to beyond the middle, apex conspicuously notched; with rows of large punctures, feebly indicated through clothing. Two basal segments of abdomen with a wide shallow depression. Legs short, third tarsal joint rounded at apex. Length, 3 mm.

Hab.—Western Australia : King George's Sound (unique).

Differs from the preceding species in being much narrower, with sides of elytra parallel for more than half their length, and with longer and thinner rostrum (this is more than four times as long as its basal width). The types of both species have a shallow depression on the abdomen, so they are presumably males. It is decidedly narrower than *T. cinerascens*, and with somewhat thinner rostrum than its male.

T. pygmaea, Pasc. Hobart.

Olanaea, sp.—A single specimen from King George's Sound appears to be a female of this genus, but, as it is in rather poor condition and probably belongs to the same species as some males in my collection that have more variegated elytral scales, it was considered undesirable to name it.

Cydmaea cara, Lea. Sydney.

C. diversa, Blackb. King George's Sound.

C. pusilla, Pasc. Sydney.

Empolis leai, Blackb. Australia.

Elleschodes tenuistriatus, Lea. Hobart.

Tychius minutissimus, Boh. Tasmania.

Rhamphus setistriatus, n. sp.

Black, basal two-thirds of antenna flavous. Upper surface with very short clothing, seriate in arrangement on the elytra.

Head with crowded punctures. Eyes almost touching at base. Rostrum narrow, its tip obscurely diluted with red, and resting on mesosternum. Prothorax much wider at base than at apex, the sides rounded posteriorly; with crowded punctures; median line not traceable. Elytra with outlines continuous with those of pro-

thorax, sides dilated to near apex; punctate-striate, interstices distinctly punctate. Length, 1·2 mm.

Hab.—Tasmania: Hobart.

The type is about the length of the British *R. ferrugineus*, but not quite so robust; in size it is much the same as *R. perpusillus*, but it is more conspicuously clothed, and the greatest width of the prothorax is more distant from the base; from *R. acaciae* it differs in being decidedly wider, and in the clothing. Of two specimens from South Australia (Murray Bridge, *A. M. Lea*) one agrees perfectly with the type, but a second is rather narrower and more sparsely clothed (possibly due to abrasion).

R. acaciae, Lea. Hobart.
R. perpusillus, Pasc. King George's Sound.
Microberosiris exilis, Lea. King George's Sound.
Decilaus moluris, Lea. King George's Sound.
Calandra oryzae, Linn. King George's Sound.

Anthribidae.

Xynotropis micans, Blackb. Tasmania.
Araeocerus lindensis, Blackb. Tasmania.

Chrysomelidae.

Monolepta subsuturalis, Blackb.—A specimen from Sydney is possibly an immature one of this species, as its under surface, except for a slight infuscation of the abdomen, is entirely pale, and its scutellum is scarcely as dark as the suture, this being less conspicuously infuscate than is usual in the species. Typical specimens have been taken in New South Wales and Tasmania, as well as in Victoria.

M. nigricornis, Blackb. Tasmania.
M. ordinaria, Blackb. Hobart.
M. sordidula, Blackb. Sydney.

Rhyparida commutabilis, Lea.—A specimen of this species was taken at Hobart and is the only one of the genus I have seen from Tasmania.

Ditropidus inconspicuus, Lea. Sydney.
D. jacobyi, Baly. King George's Sound.
D. lentulus, Chp. Sydney.
D. minutus, Lea. Hobart.
D. striatopunctatus, Lea. Sydney.
Coenobius spissus, Lea. Sydney.

Coccinellidae.

Rhizobius subhirtellus, n. sp.

Reddish-flavous, elytra piceous, with a coppery gloss, suture narrowly black. Moderately clothed with whitish, semi-decumbent pubescence; elytra, in addition, with numerous erect but not very long setae.

Head almost vertical, with fairly distinct punctures. Prothorax about twice as wide as the median length; punctures much as on head. Elytra rather strongly convex; punctures scarcely denser than on prothorax, but more sharply defined.

Abdomen with coxal lines almost touching apex of basal segment. Length, 1·5–2 mm.

Hab.—Western Australia : King George's Sound.

A briefly ovate species, in general appearance like unusually small specimens of *R. hirtellus*, but slightly wider, and the erect setae shorter and less numerous; it is about the size of *R. nitidus* and *R. plebejus*, but the head and prothorax are conspicuously paler than the elytra; the latter are usually paler about the apex than elsewhere (except for the suture, which is narrowly dark throughout). The elytral pubescence is slightly waved. Two specimens were sent, and I have taken others on Garden Island and Swan River.

Rhizobius debilis, Blackb.—Two specimens from Sydney are rather larger than usual, but appear to belong to this common and widely distributed species.

R. alphabeticus, Lea. Hobart.

R. occidentalis, Blackb. King George's Sound.

R. pulcher, Blackb. Hobart.

R. ventralis, Er. Sydney.

Scymnus flavolaterus, n. sp.

♂. Black, most of head, antennae, palpi, front angles of prothorax, and parts of legs more or less flavous. Moderately clothed with short, white, semi-decumbent pubescence.

Head flattened, with rather sharply defined punctures. Prothorax about twice as wide as the median length: punctures fairly dense and sharply defined. Elytra rather narrow, suture feebly carinate posteriorly; with crowded and sharply defined punctures. Prosternum with median ridge wide, but vanishing in front. Abdomen with coxal lines almost touching apex of basal segment subapical segment incurved to middle. Length, 2–2·25 mm.

♀. Differs in being slightly more robust, head and prothorax entirely black, and subapical segment of abdomen straight at apex.

Hab.—Tasmania : Mount Wellington.

A rather narrow subparallel species. The sexual variations in colour are much as in some forms of *S. flavifrons*, but it is very distinct from that species by its flatter, narrower, and more parallel-sided form, sparser clothing, coarser punctures, etc. Its size and outlines are much as in *S. auruginеus*, but the colours and punctures are very different. On the male the legs are mostly pale, the hind femora are deeply infuscate, the other femora and the tibiae are paler, but mostly darker than the antennae; on the female usually the only parts of the legs that are conspicuously pale are the tarsi. Each front angle of the prothorax of the male is always pale, but the pale portion varies in extent and intensity. One specimen has the elytra very dark, but scarcely black, and the front angles of the prothorax, but not the head, obscurely flavous; it is probably an immature female. There are no erect setae amongst the pubescence. One specimen was sent, but the species is common on and near the summit of the mountain.

Scymnus maestus, n. sp.

Dark castaneous-brown, tarsi flavous, head, prothorax (the sides obscurely paler), suture and most of under surface black or blackish. Moderately clothed with whitish pubescence.

Head shining and with distinct punctures. Prothorax at base about thrice the width of the median length, with fairly numerous but minute punctures. Elytra moderately long, with fairly dense, sharply defined, punctures. Abdomen with coxal lines touching margin of first segment, the suture between this and second segment feeble in middle. Length, 1·25 mm.

Hab.—Tasmania : Hobart.

A briefly elliptic, feebly convex, species, about the size of *S. vagans*, but less convex, and upper surface not uniformly dark; from very small specimens of *S. flavifrons* it differs in being more evenly convex and having decidedly coarser punctures; *S. elutus* in general appearance is very similar, but is usually slightly larger and its elytral punctures are decidedly smaller. The difference in colour between the sides and disc of prothorax, although sufficiently distinct, is not sharply pronounced on any of the specimens before me, in fact the whole upper surface, at first glance, appears black or blackish; the clothing on all appears to be somewhat abraded. Three specimens were sent, and I took one on the Huon River.

Scymnus flavifrons, Blackb.—Many specimens of this variable and widely distributed species were obtained at Sydney, Hobart and King George's Sound. The elytra are frequently somewhat reddish about the tips, but this is often obscure, and sometimes not traceable. The flavous parts of the prothorax of the male vary considerably in extent and are sometimes confined to the sides, although usually margining the apex as well. On many specimens the whole upper surface is more or less obscurely reddish-brown, usually with the prothorax infuscate in the middle. Three unusually large females were taken in Tasmania, but I have seen other Tasmanian specimens quite as large.

S. elutus, Lea. Sydney.

S. notescens, Blackb. Sydney.

S. vagans, Blackb. Hobart.

Novius bellus, Blackb. Sydney. Regarding red as the ground-colour of the elytra of this beautiful little species, the black markings are in three portions : a sutural vitta (common to both) dilated near the base and narrowed to the apex, and an irregular line commencing on the middle of the base of each elytron, obliquely directed outwards, then curved round so as to join the sutural vitta near the apex (on some specimens its connection with the vitta is thin and faint, on others it is wider and well-defined), it is usually obscurely connected with the side at the apical third, at the basal third it sends out a long spur, usually free at its tip, but occasionally again touching the vitta near apex, so that a red spot is completely enclosed.

N. sanguinolentus, Muls. Sydney.

Serangium mysticum, Blackb. Sydney.

S. obscuripes, Lea. Sydney.

A NEW SUBFAMILY OF BYTHOSCOPIDAE (JASSOIDEA, HOMOPTERA)

By W. E. China.

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[Read June 2nd, 1926.]

With Five Text-figures.

The subfamily Eurymelinae, which is entirely confined to Australia and Tasmania, is of great interest to the specialist in Jassoidea. Although, owing to the facial position of the ocelli, this group has been regarded as a division of the Bythoscopidae, it presents certain fundamental characters which are entirely different from those found in the rest of the Jassoidea, or even the Bythoscopidae, and probably warrants elevation to family rank. The thick robust hind tibiae, with their distinct spur-like teeth (fig. 1, *c*, *d* and *e*), correctly suggested to past workers a resemblance to the Cercopidae, but, as pointed out by Kirkaldy,* the hind tibial spurs in the Eurymelinae possess mobile spines at their apices, whilst in the Cercopidae they are without such spines. Dr. Pruthi,† in his monumental work on the genitalia of the Rhynchota, has now shown that although in the reduction of the basal plates, and in the flap-like subgenital plates, the subfamily approaches the Cercopidae, the rudimentary presence of basal plates and the absence of a distinct periandrium decide its actual relationship with the Jassoidea.

For many years only two genera of Eurymelinae were recognised, *Eurymela*, L. and S., and *Eurymeloides*, auct., but extensive collecting in Australia during recent years has shown that the group contains quite a number of distinct genera, and is now in need of serious revision. This work is in the hands of Prof. C. F. Baker who will, no doubt, publish it in due course. In 1924 ‡ the genus *Pogonoscopus*, China, was erected to hold a new species of Bythoscopid, *P. myrmex* from West Australia. In spite of the general resemblance to the Eurymelinae, this genus was stated to be related to *Bythoscopus*, Germ. (type *lanio*), but there is now no doubt whatsoever that *Pogonoscopus*, China, is related to the Eurymelinae, as is shown by the structure of the genitalia. The broad flap-like subgenital plates, each bearing an apical spine-like style. strongly resemble those of *Eurymela*, and are quite distinct from the narrow plates found in the Bythoscopidae. Apart from other characters, the difference between the structure of the hind tibiae in *Pogonoscopus*, and that in the typical Eurymelinae, is so great, however, that it will be advisable to split the latter into two divisions, the Eurymelini with *Eurymela*, L. and S., *Eurymelias*, Kirk. (*Eurymeloides*, auct.), *Ipo*, Kirk., and allied new genera, and the Pogonoscopini with *Pogonoscopus* and its allied genera. Since Prof. Baker, in his tentative classification, proposes to split up the Eurymelini still further, it is perhaps preferable in order to avoid confusion to elevate the Pogonoscopini to subfamily rank.

* Kirkaldy, *Leaf Hoppers*, Supplement 1907, p. 23.
† Pruthi, *Trans. Ent. Soc. London*, 1925, p. 206.
‡ China, *Ann. Mag. Nat. Hist.*, (9) xiv, p. 530, 1924.

POGONOSCOPINAE, subfam. nov.

Resembling the EURYMELINAE in the genitalia, venation, and texture and type of colouring of the tegmina, but approaching the BYTHOSCOPINAE in the shape of the head and pronotum. Differing from the EURYMELINAE in the structure and armature of the hind tibae.

The head, including the eyes, is distinctly narrower than the pronotum at the base (fig. 2), the face is longer than wide across the eyes; the ocelli are

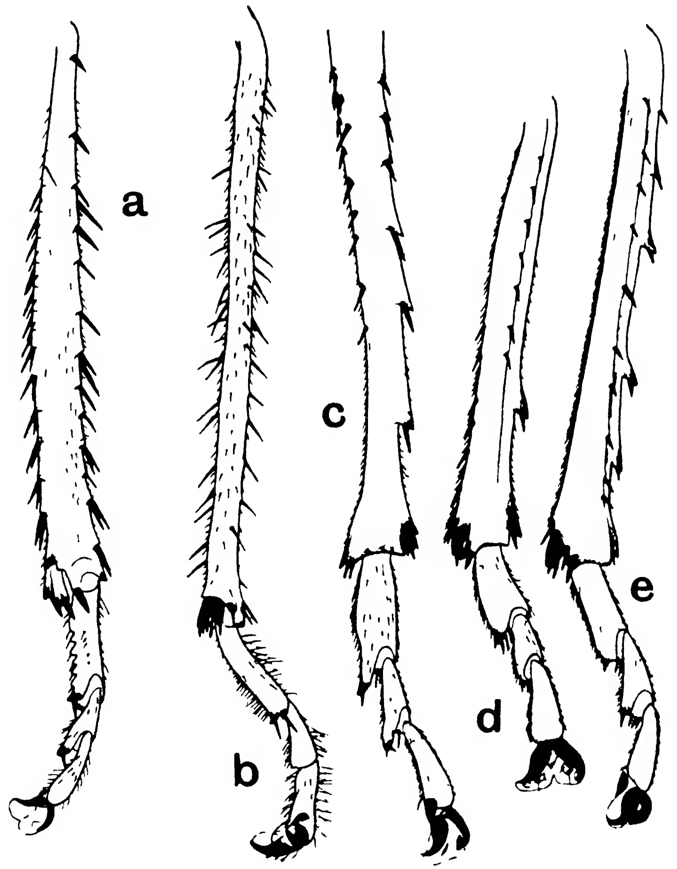

FIG. 1.—Hind tibiae and tarsi of: a. *Bythoscopus lanio*, L. (BYTHOSCOPINAE); b. *Pogonoscopus myrmex*, Ch. (POGONOSCOPINAE); c. *Ipo pellucida*, F.; d. *Eurymela fenestrata*, Lep. and Serv.; e. *Eurymelias hyacinthus*, Kirk. (EURYMELINAE).

placed close together at about the same distance from each other as from the eyes; the antennal scrobes are shallow. The tegmina (fig. 3) are opaque and leathery with the outer branch of the first sector never forked and the inner branch always forked, otherwise the venation is extremely variable and not at all constant even in the same species, the presence and absence of various supernumerary veins in the apical half of the tegmen creating a distinct variation in each individual. In the typical Bythoscopinid genera the outer branch of the first sector is usually forked whilst the inner branch is simple (*Idiocerus* and *Bythoscopus*), although in *Macropsis* (type *virescens*, F.), *Oncopsis* and

Agallia there is an oblique cross-vein between the inner branch of the first sector and the inner fork of the outer branch, so that three more or less equally long subapical cells are produced. The venation of the wings (fig. 3, *g* and *d*) in the POGONOSCOPINAE is typically Bythoscopinid. The most distinctive character of the subfamily lies in the structure of the hind tibae which are slender and almost cylindrical, with their irregular armature of spines arising direct from the tibia itself (figs. 1, *b*, and 5, *f* and *g*). In the BYTHOSCOPINAE (fig. 1, *a*) the tibiae are either quadrilateral in section (*Bythoscopus*) or more

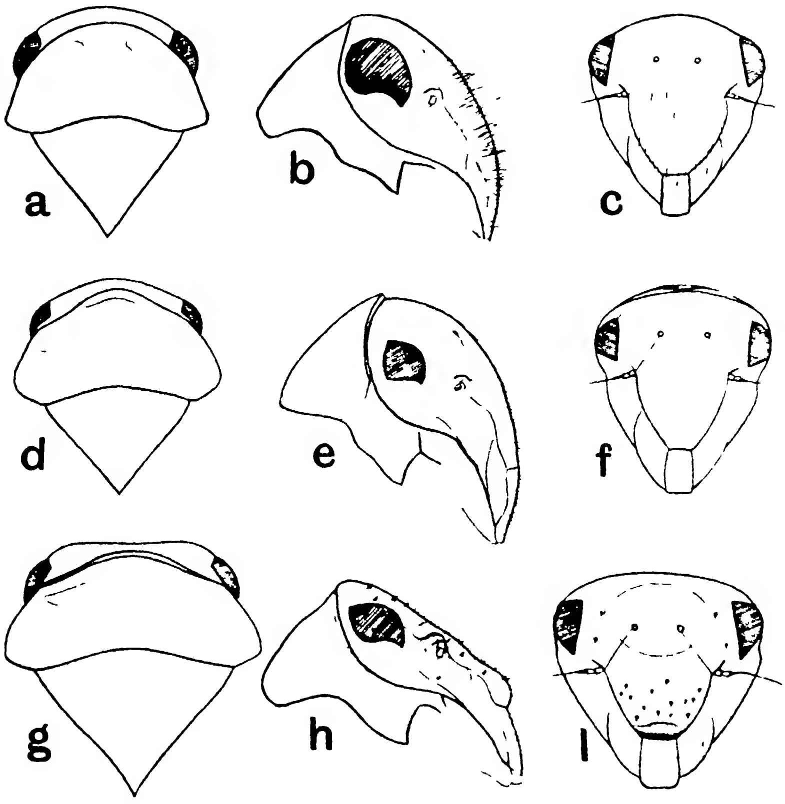

FIG. 2.—Dorsal, side, and ventral views respectively of the head, etc., of *Pogonoscopus myrmex*, Ch., a, b and c; *Australoscopus whitei*, sp. nov., d, e and f; and *Lasioscopus acmaeops*, Jac., g, h and i.

or less triangular, with the inner angle rounded. The Bythoscopinid armature is also regular, in four distinct rows, the larger spines arising from a circlet of minute teeth. In the POGONOSCOPINAE, however, the tibiae are rounded in section with the outer side flattened, and there is no circlet of minute teeth at the base of the larger spines. In the EURYMELINAE the hind tibiae are much thicker and more robust, with distinct spur-like teeth resembling those of the CERCOPIDAE, but possessing at their apices a mobile spine (fig. 1, *c*, *d* and *e*).

The POGONOSCOPINAE are apparently all myrmecophilous, being found in the nests of various Australian species of *Camponotus*. In spite of the similarity in the genitalia of the members of this group, differences in the

other structural characters have been deemed sufficient justification for the erection of three distinct genera.

Pogonoscopus, China.

Ann. Mag Nat. Hist (9) xiv, p 529 (1924).

Besides the genotype *P. myrmex*, three more species may be referred to this genus, including *P. lenis* described in 1909 by Jacobi under *Eurymeloides*, auct.

In this genus the penultimate rostral joint extends to or beyond the apices of the hind coxae.

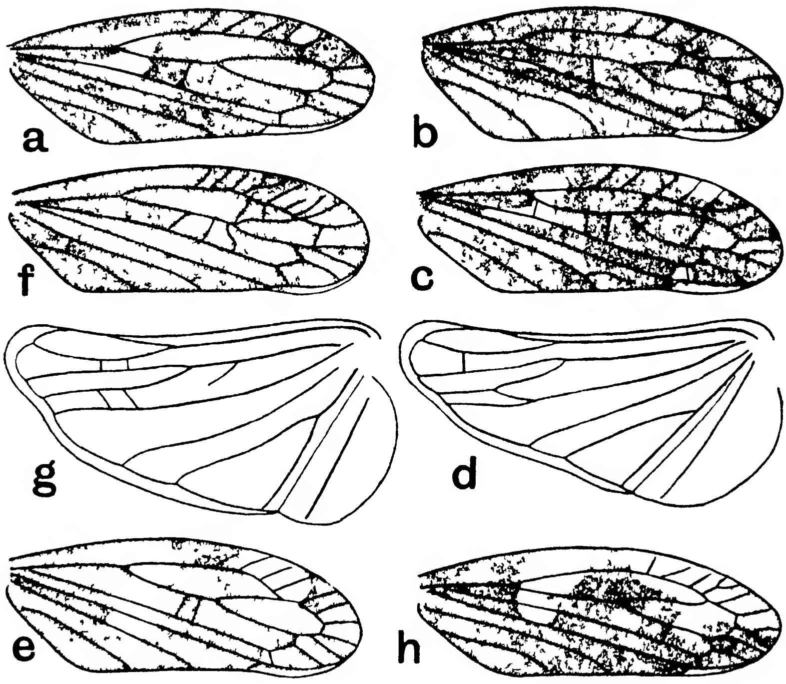

FIG. 3.—Tegmina of :—a. *Pogonoscopus clarki*, sp. nov.; b. *P. fuscus*, sp. nov.; c. *P. lenis*, Jac.; e. *P. myrmex*, Ch.; f. *Lasioscopus acmaeops*, Jac. ; h. *Australoscopus whitei*, sp. nov. Wings of :—g. *Lasioscopus acmaeops*, Jac.; d. *Pogonoscopus lenis*, Jac.

Pogonoscopus myrmex, China. (Fig. 1, *b*, fig. 2, *a*, *b* and *c*; fig. 3, *e*; fig. 4, *a* 2 and *g*; fig. 5, *a*.)

Ann Mag. Nat Hist. (9) xiv, p 530 figs (1924)

Mr. J. Clark has sent more material of this species which he states is widespread in S.W. Australia in the nests of *Camponotus* (*Myrmophyma*) *testaceipes*, Sm. He reports it from Perth, Mundaring, Busselton and Albany.

The pale markings on the tegmina are somewhat variable, and there is one specimen (♀) which I propose to call var. **confluens** nov. in which the discoidal and apical pale areas are widely confluent along the costal margin. The males are distinctly smaller than the females, measuring barely 8 mm. in length.

Pogonoscopus lenis, Jac. (Fig. 3, *c* and *d*; fig. 4, *a* 3 and *h*; fig. 5, *b*.)

Eurymeloides lenis, Jacobi, Faun. Südwest-Austral., Ergeb. d. Hamburg. S. Austral. Forschungsreise 1905, Michaelsen u. Hartmeyer, ii, 20, p. 341 (1909).

This species has nothing whatever to do with *Eurymeloides*, Kirk. & auct., which belongs to the EURYMELINAE; nor is it likely that it can be referred to *Eurymeloides*. Ashmead.* Even if Ashmead's meagre description could be applied to the hind tibial armature, he distinctly states of his genus (as belonging to the EURYMELINAE), " head as broad or broader than the thorax," and this description rules out the possibility of applying the name *Eurymeloides* to any of the Pogonoscopinid genera.

The long shaggy hairs so characteristic of the frons and clypeus of *P. myrmex* are in this species replaced by very much shorter ones.

The pale markings on the tegmina are somewhat variable in extent, and the longitudinal band along the base of the claval suture is often much reduced, especially in the male, which is smaller than the female. The pronotum and scutellum are distinctly lighter in colour than the tegmina.

Reported by Clark from nests of *Camponotus perthiana*, Forel, at Mundaring.

Pogonoscopus clarki, sp. nov. (Fig. 3, *a*; fig. 4, *a* 4 and *e*; fig. 5, *c*.)

Very similar to *P. lenis*, Jac., but with the basal pale spot of the tegmina larger, less linear, and more transverse, and the apical costal spot reduced.

Separated from *P. lenis* solely because of the difference in shape of the paramere in the male (fig. 5, *c*). The last ventrite in the female is also more widely and deeply indented in the middle than in *P. lenis*, Jac. (fig. 4, *e*).

Length, ♂ 8 mm., ♀ 10 mm.

In nests of *Camponotus perthiana*, Forel, at Mundaring and in those of *Camponotus testaceipes*, Sm., at Albany, W. Australia (*J. Clark*).

Pogonoscopus fuscus, sp. nov. (Fig. 3, *b*; fig. 4. *a* 5 and *f*; fig. 5. *d*.)

Very similar to *P. lenis*, Jac., but the general colour tone darker with the pronotum and scutellum of the same colour tone as the tegmina. Pale markings of the tegmina much reduced, practically obsolete, the apical costal spot the most pronounced. Separated from *P. lenis*, Jac., by the shape of the paramere in the

* Apart from the subfamily characters of the EURYMELINAE such as "the head as broad or broader than the thorax," the sole diagnosis of this genus given by Ashmead (*Ent. Amer.*, 5, p. 126, 1889) is " the posterior tibiae with a double row of very weak spines," no species being mentioned. Kirkaldy, however, in *Leaf Hoppers*, 1906, p. 351, accepted the genus and described in it several new species. On page 354 he fixed *E. bicincta*, Erichson, as the genotype. Now this type fixation is invalid because the hind tibial armature of *E. bicincta*, Erichs., does not agree with Ashmead's description. In *Leaf Hoppers*, Supplement 1907, p. 29, Kirkaldy realised that *Eurymeloides*, Kirk., 1906, was not covered by Ashmead's description, and erected a new genus *Eurymelias* to hold the species previously referred to *Eurymeloides*, Ashm., fixing the type as *E. hyacinthus*, Kirk.

Eurymeloides, Ashm., thus remains without a type, and so far as I know no species of Eurymelinid has as yet been described to which Ashmead's description can be accurately applied. It has been assumed that *Eurymeloides* is an Australian genus, but there is nothing in Ashmead's paper to indicate that such is the case. It is therefore advisable to let Ashmead's name stand over until a more extensive knowledge of the group enables it to be accurately appended to a definite genus. This decision will be contested by those writers who consider that such a name as *Eurymeloides*, Ashm., standing without mention of a species is invalid. From their point of view *Eurymeloides*, Kirk., 1906, is the valid genus with *E. bicincta*, Erichs., as genotype and *Eurymelias*, Kirk., 1907, as a synonym.

male (fig. 5, *d*), and by the greater number of the teeth in the female ovipositor (23) fig. 4, *a* 5. In this respect it approaches *Lasioscopus acmaeops*, Jac., in which there are 27 teeth. The last ventrite in the female approaches that of *P. myrmex*, Ch., in the shallowness of the median indentation.

Length, ♂ 8·5 mm., ♀ 9·5 mm.

In nests of *Camponotus testaceipes*, Sm., at Ludlow, and in those of *C. perthiana*, Forel, at Mundaring, W. Australia (*J. Clark*).

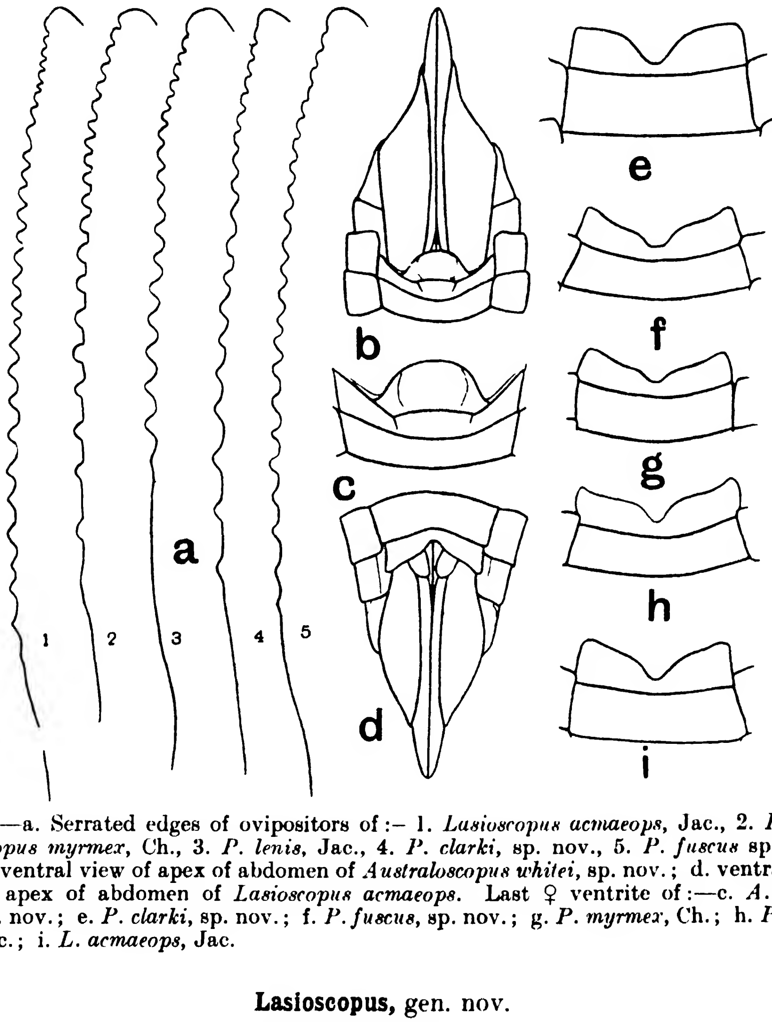

FIG. 4.—a. Serrated edges of ovipositors of :– 1. *Lasioscopus acmaeops*, Jac., 2. *Pogonoscopus myrmex*, Ch., 3. *P. lenis*, Jac., 4. *P. clarki*, sp. nov., 5. *P. fuscus* sp. nov.; b. ventral view of apex of abdomen of *Australoscopus whitei*, sp. nov.; d. ventral view of apex of abdomen of *Lasioscopus acmaeops*. Last ♀ ventrite of :—c. *A. whitei*, sp. nov.; e. *P. clarki*, sp. nov.; f. *P. fuscus*, sp. nov.; g. *P. myrmex*, Ch.; h. *P. lenis*, Jac.; i. *L. acmaeops*, Jac.

Lasioscopus, gen. nov.

Separated at once from *Pogonoscopus* by the broad flattened vertex and the flat depressed face, which is covered with short hairs and armed with scattered, short spinules especially on the frons. The apex of the frons above the clypeus is strongly swollen to form a transverse ridge (fig. 2, *h*), the supra-antennal ridges are somewhat tubercularly elevated, and the base of the frons and the vertex in the neighbourhood of the ocelli circularly depressed. The penultimate rostral joint does not extend to the apices of the hind coxae. The pronotum (fig. 2, *g*) is relatively short, more than two and a half times as broad at the base as long in the middle; the

cicatricial areas distinctly depressed; the anterior pronotal margin as in *Pogonoscopus* lightly but regularly reflexed to meet the slightly overhanging vertex.

The tegmina are without pale markings, the wings (fig. 3, *g*) with one or two supernumerary cross-veins. The armature of the hind tibiae irregular as in *Pogonoscopus*, but the spines much shorter and more robust (fig. 5, *g*). Female ovipositor with the toothed area distinctly longer than in *Pogonoscopus*, with 27 teeth instead of the usual 19 to 22 in the latter genus.

Genotype *Lasioscopus acmaeops*, Jac.

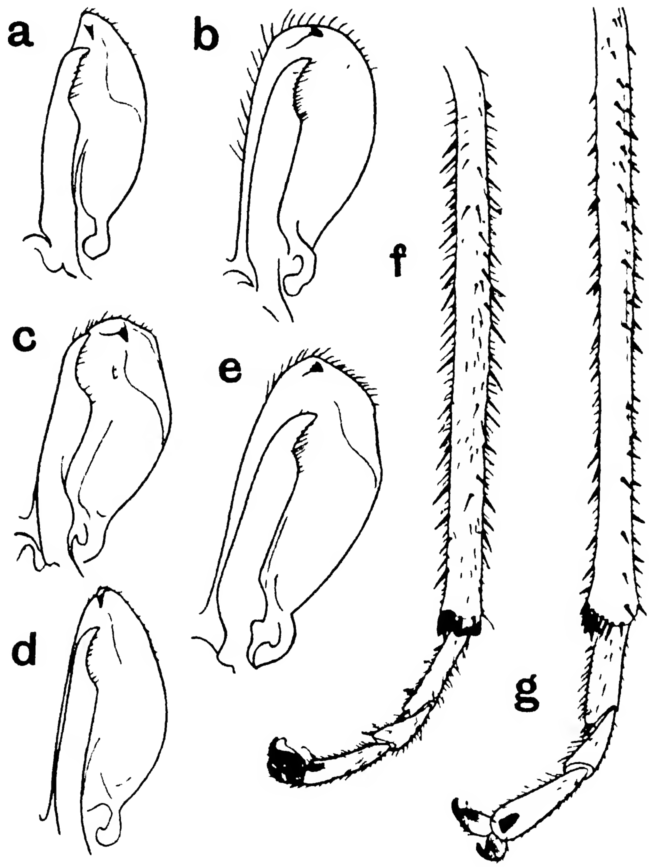

Fig. 5.—Right-hand sub-genital plate and paramere of males of :—a. *Pogonoscopus myrmex*, Ch.; b. *P. lenis*, Jac.; c. *P. clarki*, sp. nov.; d. *P. fuscus*, sp. nov.; e. *Lasioscopus acmaeops*, Jac. Hind tibia and tarsus of :—f. *Australoscopus whitei*, sp. nov., and g. *Lasioscopus acmaeops*, Jac.

Lasioscopus acmaeops, Jac. (Fig. 2, *g*, *h* and *i*; fig. 3, *f* and *g*; fig. 4, *a* 1, *d* and *i*; fig. 5, *e* and *g*).

Eurymeloides acmaeops, Jacobi, Faun. Südwest-Austral., Ergeb. d. Hamburg. S. Austral. Forschungsreise 1905, Michaelsen u. Hartmeyer, ii, 20, p. 340, fig. 5 (1909).

Colouring very constant. Numerous specimens from nests of *Camponotus testaceipes*, Sm., at Albany and Mundaring, *Camponotus clavipes*, Mayr, at Albany, and *Camponotus perthiana*, Forel, at Mundaring, W. Australia (*J. Clark*).

Australoscopus, gen. nov.

Similar to *Pogonoscopus*, Ch., in the rounded vertex and face, but differing in the narrower and more deflexed head, the type of structure of the last ventrite and the armature of the hind tibiae.

As in the two preceding genera the anterior margin of the pronotum is reflexed but not regularly, a small median section being much less elevated (fig. 2, *f*). The reflexed anterior pronotal margin, instead of meeting the posterior margin of the vertex, projects beyond the vertex so that the head is sunk beneath it (fig. 2, *e*). The breadth between the posterior margin of the eyes and that of the vertex is much greater than that in *Pogonoscopus* and *Lasioscopus*. The penultimate rostral joint extends beyond the apices of the hind coxae. Owing to the reflexed anterior pronotal margin extending beyond the posterior margin of the vertex, the pronotum from above appears to be produced anteriorly between the eyes (fig. 2, *d*) much more than in *Pogonoscopus*. The tegminal and wing venation is similar to that in the latter genus, but the armature of the hind tibiae is more dense, with much denser and longer hairs interspersed with the spines (fig. 5, *f*). The last ventrite in the ♀ instead of being indented medianly as in the two preceding genera is produced into a tongue-like process in the centre (fig. 4, *b* and *c*, compare with *Lasioscopus acmaeops*, Jac., fig. 4, *d*).

Genotype *Australoscopus whitei*, sp. nov.

Australoscopus whitei, sp. nov. (Fig. 2, *d*, *e* and *f*; fig. 3, *h*; fig. 4, *b* and *c*; fig. 5, *f*.)

♀ Rather pale chestnut brown, the vertex, the base of the frons between the frontal sutures and the pronotum about the cicatricial areas, darker. Apex of frons, clypeus, lorae, genae, anterior margin of pronotum in the middle, legs and underside brownish yellow. Tegmina chestnut brown with the costal area pale, a transverse whitish band extending from the claval suture (at one-third its length from the base), to the costal area, and another whitish area extending from the costal area over the subapical area towards the apex of the clavus but not reaching it (fig. 3, *h*). The apical costal area more or less hyaline. Front and middle femora and tibiae without spines or spinules, but densely clothed with short, bristly hairs.

Last ventrite in female produced into a round concave process (fig. 4, *c*).

Length 8 mm.

1 ♀, Charlotte Waters to Hamilton Bore, Central Australia (*Capt. S. A. White*).

THE BIOLOGY OF THE BRITISH CRABRONIDAE

By A. H. HAMM, A.L.S., assisted by O. W. RICHARDS, B.A.

[Read June 2nd, 1926.]

CONTENTS.

INTRODUCTION.

THE main purpose of this paper is to record the observations carried on by one of us (A. H. H.) during the last twenty years on the prey of the British CRABRONIDAE. We have also taken the opportunity of incorporating as far as possible all other records of English species and of summarizing everything that could be found in Continental literature upon their biology. It is probable that the habits of the CRABRONIDAE or of their parasites, observed by foreign naturalists, may also be recognised here when attention has been directed to them.

A nearly complete account of the literature of the subject is given by Kohl (F. Kohl 1915) in his monograph on the Palaearctic species, which includes a full German translation of all the published observations known to the author. It has not been considered necessary to repeat the references which are fully given by him, but, when observations are quoted from his monograph, the name of the observer will be followed by (Kohl 1915).

As regards the genera of the CRABRONIDAE we follow the nomenclature of Dr. R. C. L. Perkins, F.R.S. (Perkins 1913), except for *Solenius*, which is employed instead of *Xestocrabro* (cf. Perkins 1923).

The specific names are those of Kohl's monograph (Kohl 1915); for here it is especially important to follow the general continental usage. We also desire to express indebtedness to Berland's valuable work in the "Faune de France" series (Berland 1925).

In the identification of CRABRONIDAE much help was given by the eminent Hymenopterist, the late Edward Saunders, F.R.S.; in the determination of the prey—which, because of its variety and the imperfect condition of many specimens, was especially difficult—generous assistance has been given by the following naturalists, each of whom is indicated by initials in the third column of the list at the end of this paper (Part III):—*Diptera*—J. E. Collin, F. W. Edwards, J. R. Malloch, the late G. H. Verrall, Colbran J. Wainwright, Col. J. W. Yerbury; *Rhynchota*—the late E. A. Butler, the late E. Saunders; *Lepidoptera*—E. G. R. Waters; *Psocoptera*—the late E. Saunders. We desire especially to thank Mr. J. E. Collin for the determination of a large number of specimens.

By far the largest part of the new material described in this paper is contained in the Hamm Collection of Fossores and their Prey presented to the Hope Department in 1925, but specimens of captors and their prey presented by Dr. G. A. K. Marshall, C.M.G., F.R.S., and Col. J. W. Yerbury are also included. Furthermore, Mr. E. B. Nevinson has kindly allowed us to examine specimens

in his collection. Professor E. B. Poulton has given us every encouragement in this work and has placed all the facilities of the Hope Department at our disposal. He has also permitted us to use a number of notes on the prey of Aculeates which had been prepared for a projected paper of a similar nature to the present one.

The authors would be grateful if naturalists who have the opportunity of observing the food-habits of the Hymenoptera Aculeata but are unable to identify the prey, would lend the specimens to the Hope Department for determination and record.

The Biology of the Crabronidae.

Part I. General.

The Crabronidae are a very distinct family of the digger wasps (*Sphecoidea*), of world-wide distribution, and having thirty-seven representatives in England. As adults, a number of the species are adapted to burrow in sandy ground and are therefore restricted to such areas. Others dig in heavier soils, and some of these are common garden insects. Some species nest in rotten wood, in their own tunnels or in the deserted galleries of other insects. Such forms may be found about old fences in gardens or in woodland glades. A few species burrow in the pith of the stems of such plants as *Rubus*, *Fraxinus*, etc., and these are mainly woodland or hedgerow forms. Many of the adult wasps, especially the males, are constant visitors to the flowers of the Umbelliferae. The males of the small black species are often attracted to the flowers of nettle (*Urtica dioica*), especially when the plant is heavily infected with aphides.

The nest, whatever be its situation, may be of two main types distinguished by Kohl and others—the single system ("linearer typus") or the double system ("zweig typus"). In the first type the nest consists of a burrow containing a linear series of cells. The burrow may be somewhat moniliform in consequence of a slight dilatation for each cell. In the second type there is a main tunnel giving off small lateral galleries containing one or occasionally two or more cells in linear series. It is probable that, at least in *Blepharipus leucostomus*, L., and *Metacrabro quadricinctus*, F., (*interruptus*), there is a third type of nest. In these species a number of females have been observed (A. H. H.) to use the same main tunnel, and it is probable that each of them constructs a nest of the double system opening into the common burrow, thus constituting a triple system. Nests transitional between the first and second types may occur, as in *Physosceles clavipes*. L. The type of nest does not seem to be correlated with taxonomic affinity. It is a feature of the Crabronid nest that there is usually no special barrier closing the main burrow, though in some species it may, when stored, be completely filled with wood particles or sand. As a rule, however, there is a long stretch of empty tunnel leading to the external opening, although this unoccupied section is not uncommonly adopted by some other species. The first cell to be constructed is always that which is farthest from the surface, and the other cells follow in regular sequence so that the last is nearest to the entrance.

The prey with which the cells are filled is usually dipterous, and when other insects (e.g. *Rhynchota*) are stored there is some evidence to show that this is a secondary habit (cf. *Lindenius albilabris*, F.). In different species there is every gradation from those that are practically restricted to one genus of prey (*Thyreopus scutellatus*, F.) to those which attack insects belonging to different orders. Such wide divergence helps us to understand how it is that

specialisation has developed in various directions, as will be most fully appreciated when the summary of the prey of European species is examined. Specialisation has similarly grown up not only in the species but also in the sex of the prey selected, although in this development we have had to rely mainly on our own records. It is also interesting to observe that the sex selected for capture may be the one which, *e.g.* in the TABANIDAE, appears to be much the rarer to human observers.

This great variation in instinct does not accord with the principles laid down so axiomatically by J. H. Fabre. The conclusions of the Peckhams and other American observers are similarly opposed to those of Fabre. There is now no doubt that, within certain bounds, instinct varies as much as any morphological character.

There has been some controversy as to the method by which the prey is disabled. Adlerz has definitely recorded that *Thyreopus cribrarius*, F., (q.v.) stings its victim in the thorax, while in other species it has been suggested that death is caused by fracturing the thorax with the mandibles. We have found, however, no case of a specimen of prey with a damaged thorax. There is, probably, considerable variation in the treatment accorded to the prey and certainly in many cases it is only paralysed, although there is reason to believe that the paralysis is usually quickly followed by death.

In flight the prey, with its ventral surface uppermost, is gripped round the neck by the right or left mid tibia; as the *Crabro* enters its burrow the prey is passed back to the hind legs and held by the spurs at the end of the tibiae.

It is very difficult to understand the means by which a particular species of wasp recognises its appropriate prey. Wheeler (Wheeler 1923, p. 58: cf. also Bristowe 1925) suggests that the adult wasp may retain some traces of its experience of the food supplied to it as a larva; for the larval central nervous system is not much modified in metamorphosis. At any rate some hypothesis is needed to account for the existence within the species of local races differing in their food-habits. It is of course true, as Saunt (Saunt 1925) has pointed out in *Blepharipus leucostomus*, L., that when a species lives in several plant habitats, it will in each of these meet with different species of the order on which it preys. There is, however, a good deal of evidence, perhaps stronger in some of the other Fossorial families, that local variations in the selected prey are not merely due to the particular species available. In Crabros it is possible that there is a tendency for some individuals of a species to prey mainly on SYRPHIDAE, while other individuals chiefly attack MUSCIDAE and other dipterous families. If the process Wheeler has suggested is a reality, there need be no special hereditary mechanism for guiding instinct in its early stages; for each individual would automatically prey on the same kind of insect that its mother had provided for it. It is obvious, however, that a great deal of investigation is necessary before any safe decision can be reached. We require far more numerous records of all the prey taken by individuals, and, if possible, observations on the habits of individuals descended from parents whose habits were also known.

In the following summary references are given only for non-British species.

Summary of Prey of European Species.

Crabro fossorius, L. Dipt. ASILIDAE. Kohl 1915, p. 358. Fahringer 1922.
Clytochrysus. 4 species. Dipt. mainly SYRPHIDAE.
Solenius vagus, L. Dipt. polyphagous; SYRPHIDAE and MUSCIDAE frequent.

S. lariatus, Wesm. Dipt. polyphagous; tending to specialise on *Oncodes* (CYRTIDAE).
Metacrabro quadricinctus, F. Dipt. mainly MUSCIDAE. More ♂ than ♀.
Ectemnius dives, H-S. Dipt. MUSCIDAE. Kohl. 1915, p. 379.
E. guttatus, V. de Lind. Dipt. SYRPHIDAE. Kohl 1915, p. 380.
Ceratocolus. 2 species. Adult Lepidoptera. Kohl 1915, p. 387–8. Meyer 1919.
Thyreus clypeatus, Lep. Dipt. MUSCIDAE, EMPIDIDAE; or Lepidoptera.
Thyreopus peltarius, Schreb. and *cribrarius*, L. Dipt. mainly MUSCIDAE. Sexes about equal.
T. scutellatus, Schreb. Dipt. DOLICHOPODIDAE. Practically all ♀.
Anothyreus lapponicus, Dahlb. Dipt.; only the Leptid *Symphoromyia crassicornis*, Pz. Sexes equal. Kohl 1915, p. 394. Soot-Ryen 1924.
Cuphopterus. 2 species. Dipt. mainly Brachycera.
Acanthocrabro vagabundus, Pz. Dipt. mainly TIPULIDAE. Mainly ♀.
Hoplocrabro quadrimaculatus, Spin. Dipt. polyphagous, many Nematocera. More ♀ than ♂. A few Lepidoptera and Trichoptera.
Blepharipus capitosus, Shuck., and *cinxius*, Dahlb. (see Kohl 1915 p. 407). Mainly Dipt. More ♂ than ♀; also Hemiptera.
B. leucostoma, L. Dipt. polyphagous, especially STRATIOMYIIDAE. More ♂ than ♀. Rarely Hymenoptera.
B. pubescens, Shuck. Dipt. polyphagous. More ♀ than ♂.
B. walkeri, Shuck. EPHEMERIDAE. Mostly ♂.
B. ambiguus, Dalhb. Hemiptera, TYPHLOCYBIDAE (one Psyllid). Twice as many ♀ as ♂.
Ablepharipus podagricus, V. de Lind. Dipt. mainly SCATOPSIDAE, also other Nematocera, and *Oscinis*. More ♀ than ♂.
Crossocerus. Prey always more ♀ than ♂.
C. palmarius, Schreb. and *elongatulus*, V. de Lind. Dipt. polyphagous.
C. palmipes, L. Dipt. mainly EMPIDIDAE and acalyptrates.
C. varius, Lep. Dipt. mainly EMPIDIDAE.
C. anxius, Wesm. Dipt. EMPIDIDAE; also Hemiptera, CAPSIDAE.
C. wesmaeli, V. de Lind. Dipt. mainly CHIRONOMIDAE and EMPIDIDAE.
Tracheliodes. 2 species. Dolichoderine ants, workers. Kohl 1915, p. 427.
Lindenius armatus, V. de Lind. Parasitic Hymenoptera. Kohl 1915, p. 425.
L. albilabris, Pz. Either all Dipt., or Dipt. and Hemiptera (CAPSIDAE) or the latter only. Flies ♀. CAPSIDAE, twice as many ♀ as ♂.
L. panzeri, V. de Lind. Dipt. CHLOROPIDAE, ♂.
Physosceles clavipes, L. Dipt. Nematocera; also PSOCIDAE, PSYLLIDAE, and APHIDIDAE.
Rhopalum tibiale, Lep. Mainly Dipt. Nematocera; also CHLOROPIDAE, Aphides and one Staphylinid.

The victims are usually stuffed tightly into the cell, their backs generally downwards and all their heads directed inwards. The long curved egg is generally laid on the fly brought first to the cell, and it is attached to the ventral side of the neck, usually lying obliquely across the sternum with its free end pointing backwards. The egg hatches as a rule in from one to three days. Little is known of the early stages of the larva, which is generally full-grown in less than a fortnight, and then assumes the resting-stage, in which, if it be autumn, it will hibernate. Such a larval resting-stage has been described in a number of species, but it will not be possible to make any statement about

specific differences between the larvae until those of many species have been critically compared; little can be gathered from the descriptions of an author who has seen the larvae of only a few species.

The larva, which is of a whitish colour, has a well-defined head followed by thirteen segments. The first and second segments each bear a stigma at their posterior margin, and the fourth to thirteenth one at their anterior margin. No stigma is borne by the third segment. There are four shining lateral prominences on segments 1 to 11 and often in the male on segment twelve also. These prominences are placed one above the other on each side of a segment. Each mandible possesses four terminal teeth; the maxilla bears two small appendages, usually described as palps; the labium bears two palps and between them two palp-like processes on which the spinning-glands open. There are rudimentary antennae, considered by some authors to be ocelli.

The larva, before settling down to its resting-stage, spins its cocoon. This is oblong oval and constructed of reddish- or yellowish-brown threads. The end of the cocoon which points towards the exit hole (the end towards which the head of the larva is directed) is usually of a more compact and less open texture and may also bear a projecting ridge forming a little ring (cf. Enslin 1922*a*). The cocoon is fastened to the walls of the cell by a few fine threads. The excrement accumulated during larval life is deposited inside the cocoon at the inner end where it can be seen as a black mass. The remains of the larval food, usually found at the inner end of the cell beneath the cocoon, are sometimes in large part incorporated in its walls, and in *Physosceles clavipes*, L., according to Verhoeff (Kohl 1915), are spun together, forming a special outer covering, or " einschluss " cocoon.

In the hibernating generation the resting-larva becomes a pupa in March or April. The pupa bears lateral projections on abdominal segments 2–5 in the female and 2–6 in the male.

It is almost certain that several species pass through two or more generations in the year, but insufficient attention has been paid to the subject, especially in this country.

The parasites of the CRABRONIDAE are certain insects which attack many kinds of fossorial wasps. These parasites nearly all belong to three groups, the Tachinid flies (MILTOGRAMMINAE), the Cryptine Ichneumons, and the Chalcids. The Tachinid parasites fall into two groups—in one of which the host nests in the ground, in the other in rotten wood and plant-stems. The habits of the first group are the better known. The female parasite usually shadows a Fossor carrying prey, following about an inch in its rear and repeating every twist and turn made by the distracted wasp. In this way the nest is discovered and the parasite is able to introduce its larva; for all these flies are viviparous. The habits of the hymenopterous parasites do not seem to differ much from those of the groups to which they belong; in some cases a cocoon is not made, that of the host sufficing for the parasite.

PART II. HABITS OF PARTICULAR SPECIES.

It is not always possible to determine precisely the species of prey indicated by the names given by the older authors. We have therefore always added these names in brackets to the modern ones which, in our opinion, correspond to them.

1. **Thyreus clypeatus,** Sch. Kohl 1915, p. 383.

Extremely little is known of this species in England, where it has not been captured for many years. Perris (Kohl 1915) states that the species nests in holes of other insects in wood. The cells are 12–15 mm. long and each contains 10–15 flies. The dipterous prey, which is stored dead, consists of *Stomoxys*, *Muscina* [*Curtoneura*], *Chrysogaster*, and *Anthomyia*. He describes the nest as closed with mud mixed with quartz fragments. Most of the hard parts of the prey were left undestroyed by the larva.

Wissmann (Kohl 1915) in a very similar account describes the species as nesting in old birch-stumps and preying on *Tachydromia*. Lichtenstein (Kohl 1915) found a nest in a bramble-stem stored with adult Microlepidoptera. According to Fahringer (1922), the species nests near Vienna in old posts. The burrow penetrated almost horizontally for 7 cm. and the entrance was stopped with mud; the cell partitions were made of agglutinated wood-particles. The prey appeared to be the remains of leaf-rollers and Sesiids (*i.e.* adult Lepidoptera).

2. **Clytochrysus zonatus,** Panz. Kohl 1915, p. 359.

(*sexcinctus*, H-S., Perkins 1913 = *saundersi*, Perkins.)

Kohl (1915) found this species at Innsbruck preying on *Catabomba* [*Syrphus*] *pyrastri*, L., on the 19th of July. F. Sickmann (Kohl 1915) found it commonly in Hanover on umbellifers and on old posts, etc., where it nested gregariously. The prey was *Catabomba* [*Syrphus*] *pyrastri*, L., *Syrphus ribesii*, L., and *S. venustus*, Mg. [*hilaris*, Zett.]. The female rested on sunny leaves and stalked the prey " like a cat."

Fahringer (1922) found a burrow penetrating 20 cm. into a rotten paling near Belgrade. At the end was a single cell in which the female was hiding. This cell contained also a *Catabomba* [*Syrphus*] *pyrastri*, L., on which the egg had been laid (*i.e.* on the first prey brought in).

Perkins (1923, p. 38) finds that in Devon it forms colonies of large size and preys on Syrphidae and Sarcophagidae.

The single example of prey (*C. pyrastri*, L.) recorded in the present paper is a female.

3. **Clytochrysus planifrons,** Thoms. Kohl 1915, p. 367.

Little is certainly known of the habits of this uncommon species, and probably all records of habits under the aggregate name of " *cephalotes* " refer to the next and much commoner wasp. One trustworthy record is that of Alfken (Kohl 1915), who states that it nests in old trees and is parasitised by *Ellampus auratus*, L.

4. **Clytochrysus cavifrons,** Thoms. Kohl 1915, p. 360.

Borries (Kohl 1915) describes this species as occurring in Denmark from June to September and passing through at least two generations in fine summers. It nests in rotten wood, commonly in plum trees. The burrow after penetrating horizontally into the stem, turns and follows the grain, and most of the cells are made in the substance of the same annual ring. The nest is of the second type and the examination of a single example revealed fourteen cells. The cells are oval and about 8 mm. in diameter at their widest part. The length is 22 mm. in cells constructed for females, 15 mm. in cells for males, and there is similarly a difference in the size of the female and male cocoons. The

prey consisted of SYRPHIDAE of many genera and species very different in appearance and including both metallic and yellow-marked forms. There were 10–12 flies in a cell.

Marchal (Kohl 1915) gives a very similar account. He records the nest as formed in the old burrow of another insect enlarged by fresh excavation. Larvae of all stages were found in September. The prey included many *Syrphus ribesii*, L., *Catabomba* [*Syrphus*] *pyrastri*, L., and *Lucilia* sp.; and, in addition to these, one *Sarcophaga* sp. was recognised. The prey were stored dead, 6–10 in a cell.

Rudow (Kohl 1915) found the wasp nesting in birch-stumps and storing 5–6 *Sphaerophoria* [*Melithreptus*] in a cell. The wings of the prey had been bitten off near the base, a habit which has not been recorded for this species by other observers. Adlerz (Kohl 1915) found *C. cavifrons* in Sweden nesting in sand, the burrow being left open in the absence of the wasp.

Watkins (1895, p. 12 and p. 16) recorded as the prey of *Crabro* " *cephalotes* " in the Cotteswold valley, *Rhingia campestris*, Mg., (quoted as *rostrata*), *Syrphus ribesii*, L., and *S. balteatus*, De G. Dr. G. Arnold (in litt.) says he found this species preying on a large Syrphid with a black and yellow body, in the New Forest in 1906.

Warburton (1919) found *C. cavifrons* nesting in August at Cambridge in the hole made by a woodpecker in an elm log. The burrows in the wood were very complex and their arrangement could not be made out, though the nest must have been of the second type. The prey consisted entirely of SYRPHIDAE. It was found that, probably owing to a difficulty in crossing the woodpecker's hole to their burrows on the far side of it, the wasps lost many of their prey. These discarded specimens were never picked up by the wasp, and in October 113 specimens were collected. These were found to consist of the following:— *Syrphus balteatus*, De G., 60; *S. luniger*, Mg., 5; *S. vitripennis*, Mg., 4, *S. corollae*, F., 4; *S. auricollis*, Mg., 3; *S. albostriatus*, Fln., 1; *Platychirus albimanus*, F., 9; *P. scutatus*, Mg.?, 2; *P. peltatus*, Mg., 1; *Melanostoma mellinum*, L., 7; *M.*? *scalare*, F., 2; *Rhingia campestris*, Mg., 13; *Catabomba pyrastri*, L., 1; *Helophilus pendulus*, L., 1. The prey was thus mainly composed of the yellow-banded species.

In addition to the above we here record 24 specimens of prey, amongst which 8 are females and 14 males. It is worth noting that in the New Forest a male of *Chrysops caecutiens*, L., was taken, a species in which that sex is rarely obtained by ordinary methods. At Shotover near Oxford *cavifrons* was found (A. H. H.) nesting in a post with *Ablepharipus podagricus*, V. de Lind., and *Pemphredon lugubris*, F. The wasp came back with a Syrphid nine minutes after leaving its burrow and when depositing the prey remained in the burrow about 30 secs.

Parasites—Borries (Kohl 1915) *Eustalomyia* [*Hylemyia*] *hilaris*, Fall.: Marchal (Kohl 1915) " *Ephialtes albicinctus* " and " *Pteromalus* " sp.

Warburton (1919). A male Phorid is mentioned as entering the nest and remaining there for some minutes. A female was also seen on the log (see above). These were identified by Hugh Scott (1920) as *Aphiochaeta rufipes*, Mg., a species with the most diverse scavenging habits. Warburton also saw a probable Tachinid and an Ichneumonid parasite.

5. **Clytochrysus chrysostomus,** Lep. Kohl 1915, p. 368.

Verhoeff (Kohl 1915) found the species nesting in rotten wood, and he describes and figures the larva and pupa. The prey consisted of Syrphid flies,

especially species of *Platychirus*, but also *Syrphus*. He notes that two-thirds of the male wasps emerge before the females.

Nielsen (Kohl 1915) found this species nesting in hundreds in an old poplar. The nests were of the second type, though the side-passages were often short. The cells were of about the same width in male and female, but in the former were 11–13 mm. long, in the latter 18–20 mm. A similar dimorphism was seen in the cocoons. The males usually emerged about a fortnight before the females, and there were probably two generations in a year. The prey was very varied, but each nest contained as a rule only one species, or if several, then only nearly related species. The prey was commonly *Catabomba* [*Syrphus*] *pyrastri*, L., and other yellow-banded SYRPHIDAE, *Empis* sp., *Thereva* sp., *Phaonia* [*Aricia*] *vagans*, Fall., and related species. More rarely an all-blue species of *Onesia* and various ANTHOMYIIDAE. Alfken (Kohl 1915) found it nesting in an old willow where many of the prey were *Microchrysa polita*, L.

Fabre (1890) has stated that the species preys on SYRPHIDAE. Watkins (1892, p. 12) recorded *Platychirus fulviventris*, Mcq., as the prey in the Cotteswold valley. Fahringer (1922) found a female burrowing in a post at Floria (Constantinople) and preying on a blue *Onesia*. He adds that near Vienna it preys on *Catabomba* [*Syrphus*] *pyrastri*, L.

In the present paper 11 specimens of prey are recorded. They were obtained by Dr. G. A. K. Marshall at Wroxham, Norfolk, from a nest in rotten wood, containing the cocoons of the wasp. All were female SYRPHIDAE.

Parasites—Nielsen (Kohl 1915) records *Eustalomyia* [*Hylemyia*] *hilaris*, Fall., and *Pteromalus* sp. The latter destroyed about three-quarters of the wasp-cocoons in the poplar investigated by him. Séguy (1923, p. 138) records *Eustalomyia hilaris*, Fall., *Pachyophthalmus signatus*, Mg., and *Macronychia polyodon*, Mg. The first-named fly was hyperparasitised by a Chalcid, *Mischogaster* sp.

6. **Solenius larvatus**, Wesm. Kohl 1915, p. 374.

(*Xestocrabro microstictus*, H-S., Perkins 1913.)

There is a certain difficulty in the nomenclature of this species arising mainly from the problematical identity of *Solenius rubicola*, Dufour and Perris. Kohl (1915, p. 373) regards this species as probably the *laevigatus* of Destefani. Enslin (1922), however, thinks that *rubicola*, Duf. et Perr., is in reality *larvatus*. As regards the actual specimen whose habits Dufour and Perris described, Enslin is probably right, but it is better to avoid the name *rubicola*, because, as pointed out by Berland (1925, p. 198), several different species were included under that name in the original description. *Larvatus*, Wesm., seems therefore to be the most convenient name for this species.

Dufour and Perris (Kohl 1915) describe the nests in bramble-stems and rotten wood, and they figure the nest and larva. The only prey appeared to be *Lauxania aenea*, Fall. H. Tournier (Kohl 1915) found a nest in an elder-stem. The diameter of the burrow was 5 mm. and the burrow 30 cm. deep. The cells contained 7–8 *Oncodes* [*Henops*] *gibbosus*, L., and the egg was laid on the first-stored fly.

J. R. Sahlberg (Kohl 1915) records a nest near Petrosavodðk (Finland) in the stem of the annual plant *Synantherea*. The prey, so far as it could be identified, was *Oncodes* [*Henops*] *marginatus*, Mg., and *Trichopticus* [*Aricia*] *innocuus*, Zett. H. Höppner (Kohl 1915) found the nest commonly in stems of *Rubus*, on the lower Rhine. The tunnels were very deep—sometimes pene-

trating 30 cm.—and held up to 17 cells. Remains of prey appeared to be MUSCIDAE and SYRPHIDAE.

The best account of this species is that given by Enslin (1922*a*), who found it in Germany nesting in dry broken stems of *Rubus* and *Sambucus*. The nests were of the linear type. A tunnel 30 cm. deep was followed by a series of not more than 16 cells and usually much fewer. The cells were 10 mm. in diameter and 15 mm. long, the partitions between them 4–18 mm. thick. The larva and pupa are also described. In the empty anterior part of the burrow other Hymenoptera, e.g. *Trypoxylon*, *Ancistrocerus trifasciatus*, Oliv., etc., sometimes nested, but this was uncommon. The prey consisted of SYRPHIDAE, TRYPETIDAE, ANTHOMYIIDAE, and MUSCIDAE. Although quite different species might be stored in the same cell, there was a tendency for the prey of each nest to be restricted to a few species, and nests were often found containing only *Oncodes zonatus*, Er., a species of fly not otherwise in the district. There is thus a marked tendency for this species to prey on CYRTIDAE,* which renders it probable that the following record by H. S. Gorham (1902) refers to *S. larvatus*, Wesm. This author recorded the finding of a *Crabro* which stored upwards of fifty specimens of *Oncodes gibbosus*, L., in the stem of *Cirsium palustre* in the New Forest. He gives his *Crabro* the name *interruptus*, on the authority of the Rev. F. D. Morice. It seems probable that Gorham took and sent for identification another specimen of *Crabro* which he believed to be the same species; the habits he describes do not correspond with those of *interruptus*.

Parasites—Tournier (Kohl 1915) records a Pteromalid of a genus near *Brachirision*, Costa. Höppner (Kohl 1915) records the Chalcid *Diomorus kollari*, Foerst. Enslin (1922) found as Dipterous parasites *Eustalomyia hilaris*, Fall., *Macromychia polyodon*, Mg., and *Sphecapata tricuspis*, Mg.; also an unidentified Tachinid, either a *Plagia* or a *Voria*. The pupae of these flies were found in the burrow outside the cells which they had quitted for pupation. All the flies were hyperparasitised by the Chalcid *Dibrachys boucheanus*, Ratz. Chalcid parasites of the wasp were *Diomorus kollari*, Foerst., and *Eurytoma nodularis*, Boh. Enslin describes the larva of the former, which was very tenacious of life and not only survived four hours in a cyanide-bottle followed by six hours in the vapour of acetic ether, but pupated and produced a normal adult. Amongst the Cryptine parasites were *Kaltenbachia dentata*, Taschbg., *Hoplocryptus quadriguttatus*, Grav., *H. fugitivus*, Grav., var. *mallorcanus*, Kriechb., and *Cecidonomus inimicus*, Bridgman. The author gives reasons for supposing that the two above-mentioned species of *Hoplocryptus* are really colour-varieties of one species. He also found that *Hoplocryptus binotatulus*, Thoms., was a hyperparasite of *Cecidonomus*. On one occasion *Chrysis cyanea*, L., was bred from the *Crabro*, and Enslin also refers to the observation of Borries that *Mutilla rufipes*, F., was parasitic upon it at Trieste. Berland (1925, p. 332) records *Cystomutilla ruficeps*, Sm., also as a parasite.

7. **Solenius vagus**, L. Kohl 1915, p. 377.

Westwood (Kohl 1915) recorded this species as preying on "blue-bottles," *Calliphora* (presumably). A. J. F. Fokker (Kohl 1915) gave *Calliphora vomitoria*, L., and *Lucilia caesar*, L., as the prey. Nielsen (Kohl 1915) found the species nesting in branches of oak and hornbeam, and also in an old pine

* Westwood (*Introduction to the Modern Classification of Insects*, Vol. II, 1840, p. 189) says he has been told by Herr van Heyden and M. Audouin that there is a Fossor [genus and species not mentioned] that preys solely on *Oncodes* [*Ogcodes*] *gibbosus*, L.

post. The burrow was a straight tunnel 5–12 cm. long and 4–5 mm. wide. Each nest had usually 3 cells occupying dilatations of the tunnel 12 × 8 mm. in size. The only prey was *Melanostoma mellinum*, L., arranged with every head pointing inwards and the thorax damaged by the wasp. A nest in a pine post, however, was of the second type, having short side-passages ending in one or two cells. Here it was found that cells for males were 15–17 mm. long and 6·5–7·5 mm. wide, while those for females were 20–22 mm. long and 7–8 mm. wide. The prey consisted of SYRPHIDAE and *Onesia*. Alderz (Kohl 1915) describes a nest of the second type in an old birch trunk lying on the ground. There were eight cells, one in the process of being stored. The seven completed cells contained 6–8 flies each ; in two of them the wasp larva had failed to develop. The prey was mostly made up of MUSCIDAE and ANTHOMYIIDAE, occasionally also *Haematopota pluvialis*, L., and *Thereva*. The thorax of these flies was undamaged.

Fabre (1890) recorded as prey, flies of the genera *Syritta*, *Paragus*, *Sphaerophoria*, *Sarcophaga*, *Syrphus*, *Melanophora* and many others ; *Syritta pipiens*, L., being apparently the commonest. Marchal (1893, p. 337) recorded *Thereva* sp. as the prey.

Watkins (1895, p. 11) recorded *Musca* sp. and *Pollenia* sp. as the prey in the Cotteswold valley. Fahringer (1922) records the wasp preying on a blue-black Muscid near Constantinople, where it was nesting in the stem of *Sambucus*. G. H. Verrall (1901, p. 399) records that " *Syrphus auricollis*, Mg., seems to be the main species stored up by *Crabro varus* to provide food for its larvae, as in its burrows there occur masses of *S. auricollis*, Mg. (4 ♂, 3 ♀) with their heads all pointing in one direction, while a pair of *S. balteatus*, Deg., occurred in company." It is impossible to conclude from the text whether this is an original observation, but the *Crabro* alluded to is probably *Solenius vagus*, L.

In the present paper 39 insects captured as prey are recorded, most of these identified from fragments. Of specimens in a satisfactory condition 5 were males and 3 females. In a nest from Wicken Fen was a male of the Tabanid *Chrysops relicta*, Mg., although the male is usually very much rarer than the female. The burrows of this nest, also, were almost continuous with a nest of *Psammochares cardui*, Perk. (*piliventris*, Mor.), which was probably using an old burrow of the *Crabro*. Both the nests from which the prey was taken were in rotten wood.

8. **Metacrabro quadricinctus**, F. (*interruptus*, Auct.). Kohl 1915, p. 358.

Kohl (1915) observed a cocoon of this species with the remains of *Pollenia rudis*, L., included in the web.

Nielsen (Kohl 1915) found a nest in a nearly new oak post. The nest was of the second type with short side-passages. The cells were 12–17 mm. long for the males, and 20–22 mm. long for the females. They contained remains of *Chrysops* and *Calliphora*.

In the present paper 147 specimens of prey, 84 ♂ and 63 ♀, are recorded, mainly from a colony near Newbury, Berks., and from one in the New Forest (A. H. H.). The prey is mainly MUSCIDAE (s. l.), although SYRPHIDAE and also various Brachycera are also present. In the colony at Newbury some experimental evidence was obtained supporting the view that SYRPHIDAE were the prey of particular individuals only. The prey from this colony consisted of 105 Muscids and 16 Syrphids. A female was caught carrying a ♂ *S. ribesii*, L.; her prey was removed and her left wing clipped at the tip. She was set free and her burrow stopped up. She brought back two more Syrphids (♂ *S. ribesii*, L.,

♂ *S. vitripennis*, Mg.) before the experiment ended owing to a thunderstorm. It is unlikely, on the theory of chances, that an individual should catch three Syrphids running, when in the whole colony nearly seven times as many Muscids were being caught. In the New Forest *Tabanus glaucus*, Mg., was represented by two males, the rarer sex in TABANIDAE. In the Newbury colony it was found that many females entered the same burrow; the main tunnel of the nest must, therefore, be communal in this species, and probably each female has a nest of the second type leading from it, although this conclusion was not tested by excavating the nests. The entrance-holes were near the ground, the colony being in the old and very rotten, prostrate trunk of an oak. The excavations of the wasps had produced large piles of wood-dust. The Crabronids were so numerous that some boys who happened to be near thought the colony was a "wasps' nest" and had attempted to barricade it with stones.

9. **Metacrabro lituratus**, Pz.

This species has been bred from cocoons found in the stump of an old ash at Dawlish, S. Devon, by A. E. Holdaway in 1899. Attached to the cocoons were the wings of flies, probably either ANTHOMYIIDAE or CORDYLURIDAE.

10. **Thyreopus cribrarius**, Fab. Kohl 1915, p. 390.

Kohl (1915) found this species at Bözen (Bolzano), nesting in the earth, or in rotten wood if sufficiently soft, and preying on flies, including *Merodon avidus*, Rnd.

Sickmann (Kohl 1915) recorded the same nesting-sites, and *Stomoxys calcitrans*, L., as one of the flies preyed upon.

Adlerz (Kohl 1915) found this species very commonly in Sweden, from the end of June to the end of September. The wasps flew amongst scattered plants, and the females pounced upon, but often missed the flies resting on the leaves. The entrance of the burrows, which were dug in sand, was often partly concealed beneath a leaf. The tunnel struck perpendicularly downwards for 15–20 cm. and then turned at a right angle, forming a section from which the side-passages led to the cells. The prey was made up of moderate-sized flies, mostly MUSCIDAE and ANTHOMYIIDAE.

Rudow (Kohl 1915) records that the species nests in the subterranean part of the stem of thistles, *Onopordon* and *Verbascum*. Morawitz (1867) observed that this wasp preyed on large flies, chiefly ASILIDAE, in the Upper Engadine.

Carr (1916) found the species nesting in sandy places in Nottinghamshire, and records as prey—*Calliphora erythrocephala*, Mg.; *Hylemyia strigosa*, F.; *Pollenia rudis*, F., (2); and *Thereva nobilitata*, F., (2).

Fahringer (1922) found the species nesting in sand near Belgrade; the burrows started perpendicularly, but ended horizontally. The sides were carefully smoothed. There was only one cell, a dilatation of the end of the burrow. The prey was *Stomoxys calcitrans*, L.

In the present paper 26 specimens of prey are recorded, of which 16 are male, 10 female. An individual observed at Hogley Bog, near Oxford (4 Aug., 1909) caught four specimens of *Pollenia rudis*, L., successively, although the colony, as a whole, was also capturing *Thereva*. The following notes were made on the behaviour of the *cribrarius* in question:—It arrived carrying a *Pollenia* at 1.2 p.m.; the fly was taken from it and the wasp flew away at 1.20. It returned with another fly at 1.33 p.m., when the fly was taken and it flew away 1.50. Returned with fly 1.58; fly taken and wasp flew away 2.31. Returned without

prey after 3.0 p.m., and retired for the night. The next day it was caught with another fly. When the prey was taken from it, the wasp would hunt all round the burrow, then enter the burrow, then come out and search again, not giving up for a considerable time.

In catching its prey the wasp hovers for a moment and then darts at flies settled on the herbage. One specimen, watched continuously for twenty minutes, pounced frequently without capturing any prey.

A successful attack was once seen :—the wasp and its victim rolled over and over on the ground for a few seconds at the end of which the fly was paralysed. This had probably been brought about by stinging, certainly not by biting.

11. **Thyreopus peltarius,** Schreb. Kohl 1915, p. 391.

Dahlbom (Kohl 1915) states that this wasp nests in sand and preys on *Thereva anilis*, L., *Helina* [*Anthomyia*] *impuncta*, Fall., and *Spilogaster* [*Aricia*] *lucorum*, Fln.

Kohl (1915) found this wasp preying on both sexes of *Pollenia rudis*, L. Simon (Kohl 1915) found the species commonly nesting in sandy places near Salzburg, but it was not gregarious. The prey was *Sargus cuprarius*, L.

Sickmann (Kohl 1915) found that near Osnabrück the species nearly always nested in sand and only exceptionally in more heavy soils. The burrow is dug with the mandibles and fore feet, the excavated sand being shot out backwards by the aid of the hind feet. The prey consisted of the females of *Sargus cuprarius*, L., *S. infuscatus*, Mg., *S. nubeculosus*, Zett., *Haematopota pluvialis*, L., *Thereva anilis*, L., *Thereva ardea*, F., *Melanostoma mellinum*, L., *M. mallium*, L., *Tachina erucarum*, Rnd., *T. nitidula*, Mg., *Masicera proxima*, Egg., *Onesia sepulchralis*, Mg., *Pollenia rudis*, F., *Helina* [*Spilogaster*] *quadrum*, Fall., *H.* [*S.*] *impuncta*, Fall., *Spilogaster duplicata*, Mg., *S. tetrastigma*, Mg., *Ophyra leucostoma*, Wied., *Hylemyia variata*, Fall., *H. nigrimana*, Mg., *Fannia* [*Homalomyia*] *armata*, Mg., *Egle* [*Anthomyia*] *radicum*, L., *Chortophila sepia*, Mg., *Coenosia tigrina*, F., var. *leonina*, Rnd. The female when returning with prey hovered for a moment over her nest and then flew straight into it. In the night and in wet weather the females hide in their burrows, while the males seek holes in posts. After prolonged wet weather the females become very torpid and probably many of them do not recover.

Borries (Kohl 1915) found the species in Denmark, nesting in a sandy path. The whole tunnel was six inches long, and its termination was four inches beneath the surface. There appeared to be no cells at the end of the burrow, but several were connected by short side-passages to the main burrow at a point where it bent from the vertical to the horizontal direction. The walls of the cells had not been smoothed. The three cells were stored with 9, 11 and 16 flies respectively. One cell contained, amongst other flies, 1 ♂ 1 ♀ *Musca corvina*, F., 1 *Microchrysa* [*Chrysomyia*] sp., 6 *Anthomyia* sp.; another cell 6 *Anthomyia* sp., 1 *Fannia* [*Homalomyia*] sp., and 1 *Tachina* sp. When the nest is complete the side-passages and the main tunnel are filled with sand.

Adlerz (Kohl 1915) found the species in Sweden using the burrow of a *Halictus* and preying on ANTHOMYIIDAE. On another occasion it was seen to prey on the snow-white male of a *Thereva*. The wasp pounced on a settled fly and was distinctly seen to sting it on the sternum.

Alfken (Kohl 1915) records *Thereva plebeia*, L., ♀, and *Macquartia tenebricosa*, Mg., as the prey near Bremen. Nielsen (1907) states that the species preys on TACHINIDAE. Halkyard (1923) records *Calliphora erythrocephala*, Mg., as prey in Delamere forest; Perkins (1923) *Thereva* sp. at Dawlish.

Fahringer (1922) observed a female of this wasp caught and killed by the crab-spider *Thomisus albus*, L., on the flowers of *Sambucus ebulus*, near Belgrade.

In the present paper 8 specimens of prey are recorded, 6 ♂ and 2 ♀. The nests have always been found in sandy situations.

Parasites—Alfken (Kohl 1915) records *Sphecapata conica*, Fall., as does also Kramer (1917). Baer (1921, p. 188), in addition to this fly, records also *Metopia leucocephala*, Rossi. *S. conica*, Fall., ♀, was seen by A. H. Hamm following a female of the wasp carrying prey on Shotover Hill, near Oxford, 28 July, 1917.

12. **Thyreopus scutellatus,** F. Kohl 1915, p. 394.

Sickmann (Kohl 1915) says that this species nests with *Th. peltarius*, and catches flies, especially species of *Sargus*. It is possible that the author was not observing *scutellatus*, but the variety of *peltarius* in which the first abdominal tergite is entirely black. The habits of *scutellatus* recorded here are at variance with his observations.

This wasp was observed by A. H. Hamm nesting gregariously in considerable numbers at Denny Bog, New Forest.* The nests were found in quite damp sand. Mr. E. B. Nevinson, however, tells us that in the Cobham district (Surrey) it always frequents hard sandy paths. In the New Forest the tunnel went down perpendicularly and the cells were at the end of short side-passages coming off at irregular intervals. From this colony 174 specimens of prey are recorded, of which only 4 are males, and all but 6 are included in the genus *Dolichopus*, the exceptions belonging to other genera in the same family. It is worth noting that four of the exceptional species of prey and also three of the exceptional males, were found together in one cell, which probably belonged to an eccentric individual. The following are the number of flies in fully stored cells :–8, 13, 14, 18, 18, 19. Three cells of one individual contained 8, 9, 13, and of another 13, 18, 18. It is possible that this variation in number may be connected with rationing for the sexes. On 14 August, 1908, two females of *Sphecapata conica*, Fall., were seen following a female wasp with prey.

13. **Blepharipus leucostomus,** L. Kohl 1915, p. 409.

Westwood (Kohl 1915) states that this species nests in rotten wood and preys on *Anthomyia pluvialis*, L. In a pencil note on the margin of a copy of Shuckard's "Fossorial Hymenoptera" in the Hope Library, there is also a record that he found this wasp nesting in a wooden grating on a level with the ground (5 June, 1841). The burrows were excavated in a part where the wood was very rotten. The prey, described as a small green Chloromyid, was carried by the midlegs of the wasp. A ♂ and ♀ of *Microchrysa polita*, L., placed next to the wasp in the Hope Collection, are evidently the specimens mentioned in the note. Prof. Westwood adds that the wasp preys also on ANTHOMYIIDAE.

Dahlbom (Kohl 1915) records as prey *Sphaerophoria menthastri*, Fall. According to Goureau (Kohl 1915) *leucostomus* nests in the old larval galleries of *Oberea* [*Saperda*] *pupillata*, Gyll., in the branches of *Lonicera caprifolium*, and preys on *Sargus* and *Microchrysa* [*Chrysomyia*]. Nielsen (Kohl 1915) found the nests locally common in Denmark in the galls of *Saperda populnea*, L., in the branches of *Populus tremula*. Such nests contained only a single cell, or rarely two. The cells for females were 10 mm. long, for males 7–8 mm. The prey

* This colony was first discovered by Dr. G. Arnold.

was a species of *Dolichopus*. The adults appeared in early June, the males a few days before the females. He subsequently recorded a nest in the larval frass filling a burrow in a beech-branch, probably made by *Cerambyx cerdo*, L. The prey consisted of small EMPIDIDAE and MUSCIDAE.

V. R. Perkins (1892) found this species nesting gregariously in the lintel of a garden-door, and preying on *Microchrysa* [*Chrysomyia*] *polita*, L. Watkins (1895, p. 10) found it in the Cotteswold Valley preying on *Microchrysa polita*, L., and *Melanostoma*, probably *mellinum*, L. Saunders (1896, p. 129) found the species nesting in the lintel of a door at Woking; at 5 p.m., 6 or 8 females were seen to enter the same hole, but none were seen to come out.

Wallis (1919) found the nest of a *Crabro* at Newton, near Kettering, and the list of prey makes it almost certain that the species was *leucostomus*. He records in one cell :—2 *Nemopoda cylindrica*, F., 1 *Dolichopus*, large sp., 3 *Beris vallata*, Forst., 3 *B. chalybeata*, Forst., 1 *Ophyra leucostoma*, Wied., 2 *Hydrotaea* or *Phaonia* sp. [*Hyetodesia*], 1 *Chyliza*, probably *annulipes*, Mcq., 1 *Microchrysa* L. Also in a second cell :—8 *Chyliza*, 1 *Ophyra leucostoma*, Wied., 1 Dolichopodid. In a third :—1 *Phaonia* [*Hyetodesia*], 1 *Microchrysa polita*, L., 9 *Chyliza*, 1 *Neurigona* sp?, 1 *Phorbia*, 1 *Medeterus*. A fourth cell contained fragments mostly of *Chyliza*.

Séguy (1923) records *Anthomyia pluvialis*, Fln., as the prey in France. Saunt (1925) bred the species from a piece of rotten wood found at Foleshill, the prey being without exception *Microchrysa polita*, L. On 10 September, 1921, he observed it nesting in an oak-stump in the Wyre Forest. The prey included 1 *Platychirus* sp., 1 *Coenosia sexnotata*, Mg., 1 *Musca corvina*, F., 36 *Tephritis bardanae*, Schrk., and 1 *Sepsis cynipsea*, L. Saunt records May 16th as the earliest date at which he has seen the wasp, and October 24th as the latest, also that it occurs in all the intervening months.

In the present paper we record 143 specimens of prey—75 ♂ and 68 ♀. A colony at Relubbus, W. Cornwall, observed by O. W. Richards, nested in a very rotten log lying on the ground at the edge of a grassy path near a stream. The occurrence of a single sawfly amongst the prey is remarkable. In two widely separated localities (New Forest and Oxford) it was found by A. H. Hamm that many females, laden with prey, entered the same burrow, and each of these must almost certainly have had a nest of its own, branching off from the main passage. In the New Forest the colony was in an old dead beech-tree lying on the ground. The burrow had been made in the small cavity formed where a little branch had been broken off at its base. At Oxford the colony was in an old rotten elm. A piece of bark and some of the underlying wood had been removed, probably by a woodpecker, and in this hole, about 2 inches in diameter, the burrow had been sunk.

Parasites—Nielsen (Kohl 1915) records *Cryptus analis*, Grav., which pupates inside the cocoon of its host; also a small Tachinid. Morley (1911, p. 186) gives *Tryphon signator*, Grav., as a probable parasite. Saunt (1925) records the Chalcid *Habritys brevicornis*, Ratz. In the cells of the abovementioned colony at Relubbus was an Anthomyid larva, perhaps that of *Eustalomyia festiva*, Ztt., a fly which was bred from the cells of this wasp in rotten wood at Shotover, near Oxford (A. H. H.).

14. **Blepharipus pubescens,** Shuck. (*nigritus*, Lep., Perkins 1913) and var. *inermis*, Thoms. Kohl 1915, p. 410.

These two forms almost certainly belong to the same species, and on the continent the habits have been studied mainly in the variety. Enslin (1922*b*)

records that the typical form and especially the variety are common in N. Bavaria, nesting in the stems of *Sambucus*. Hugh Scott (1925) records the finding of a nest of typical *pubescens* by Dr. R. C. L. Perkins at Newton Abbot, S. Devon. It had been formed in the stem of a healthy *Typha*, so that the interior of the cells was very damp. The nest consisted of four cells, of which one contained only one or two flies, two were fully stored and contained an egg and a young larva, respectively, while in the fourth a full-grown larva had eaten all the prey. The site of the nest was perhaps unusual, for in Gloucestershire Dr. Perkins has found the species burrowing in the dead wood of old beech-stumps. The prey consisted of:—*Ceratopogon rubiginosus*, Winn., 1 ♀; *Chloropisca circumdata*, Mg., 1 ♀; *Chrysotus blepharosceles*, Kow., 6 ♂ 3 ♀; *Ch. gramineus*, Fall., 4 ♂ 26 ♀; *Fannia polychaeta*, Stein., 1 ♀; *Limnophora humilis*, Zett., 2 ♀; *Notiphila riparia*, Mg. 1 ♂; *Pipunculus campestris*, (Latr.) Verr., 1 ♀; *P. fuscus*, Zett., 1 ♂; *P. geniculatus*, Mg., 1 ♂; *P. horridus*, Beck., 2 ♂ 1 ♀; *Sepsis* sp., 1 ♀; *Tachydromia pallidiventris*, Mg., 3 ♀; *Trineura* sp., 1 ♀—in all 41 ♀ and 15 ♂.

Verhoeff (Kohl 1915), who renamed the species *sambulicola*, found the nests of the variety commonly in elder stems. The prey was *Microchrysa* [*Chrysomyia*] *polita*, L., and Muscids, probably *Muscina* [*Cyrtoneura*] sp. The nests had 4–6 cells each. In the early summer the males hatched out, as a rule, some days before the females.

Parasites—Enslin (1922*b*) records *Diomorus armatus*, Boh., as a parasite of both the typical form and its variety.

15. **Blepharipus capitosus,** Shuck. Kohl 1915, p. 401.

Verhoeff (Kohl 1915) finds that the nests are hollowed out in the pith of plant-stems, and that the cells are arranged in simple linear order. The prey in one nest consisted of Empidids—apparently two species of *Tachydromia* [*Platypalpus*], and in another of small black gnats (Nematocera). The male wasps emerge a few days before the females.

Borries (Kohl 1915) states that the species occurs from June to August in Denmark. Pairing takes place in June and the female nests in July and August. There is only a single generation in the year. The nest, which is excavated in stems of raspberry, ash, or elder, is absolutely simple and linear. The length of the cells varies greatly, being determined by the diameter of the stem. Nests in raspberry usually have 15–18 cells, but those in ash or elder only 1 or 2; each female must therefore make several such nests in these trees. The males seem to be much commoner than the females, and a nest of 15–16 cells may contain only one or but a few females, which are nearly always found in the inner cells. Sometimes whole nests are stored with prey but without larvae. Such nests were probably made towards the end of the season when the eggs of the female were exhausted. The prey, of which there are about 20 in a cell, included various species of *Chironomus* and *Ceratopogon* (both sexes). The cocoon is transparent reddish-yellow, about 6 mm. long, 3 mm. broad, and nearly cylindrical.

Baer (Kohl 1915) found the nests, with not more than six cells, in the pruned twigs of *Fraxinus excelsior*, var. *pendulus*. The prey consisted of *Tachydromia*, and various Nematocera, including *Sciara*. Box (1919) writes of the nests as very common in living stems of ash, more rarely elder, in the Midlands. He finds, like most other authors, that the nests are much commoner than the adult wasps. The tunnel penetrates the living pith for a distance of over a foot. The prey, he states, consisted of aphids.

In the present paper 81 specimens of prey are recorded, mostly identified from fragments. Of those which can be sexed 51 are ♂ and 26 are ♀. In addition to various Diptera one nest contained fragments of *Psylla* sp., while another of 5 cells appeared to have PSYLLIDAE only. There is less diversity in the species of prey found in individual nests than in the prey of the species as a whole, thus leading to the inference that there is a certain amount of individual specialisation in hunting and capture. In one nest of seven cells the larva in the fourth cell lay with its head pointing inwards—a curious abnormality. The nests have been found in various localities near Oxford in the stems—often living—of ash, *Viburnum lantana*, elder and sumach (*Rhus coriaria*).

Parasites—Kramer (1920) in Germany bred *Macronychia polyodon*, Mg., *Ptychoneura cylindrica*, Fall., and *P. crabronum*, Kramer. The last-named species is placed by Stein in the genus *Sphecapata*. At Stanmore, Middlesex, a nest in an elder stem, found by O. W. Richards, contained one puparium of *Macronychia polyodon*, Mg.

On the continent a closely allied Crabro, viz. *B. cinxius*, Dahlb., has very similar habits, also mixing Hemiptera with its flies; much also has been recorded of its parasites. The species, which should be looked for in England, may be distinguished from *B. capitosus* by the broader process of the clypeus and by lacking the yellow patch on the anterior side of the front tibiae.

16. **Blepharipus cetratus,** Shuck. Kohl 1915, p. 410.

Bold (Kohl 1915) records that he found this species in 1853 preying on green aphids in Northumberland. It is, however, very doubtful whether any British naturalist could, at that date, correctly identify the small black Crabros, and it is quite probable that there were also errors of observation. Dr. Sharp (Hugh Scott 1925) took a female in the New Forest which had captured three females of the gnat *Johannseniella nitida*, Mcq.

17. **Blepharipus ambiguus,** Dahlb. Kohl 1915, p. 415 (*gonager*, Lep., Perkins 1913).

Kohl (1915) only quotes from Borries a doubtful record of this species nesting in rotten wood, in Denmark. Meyer (1919) also states that the species nests in wood. Jannson (1919) found it nesting in a rotten poplar in August at Oerebro, Sweden. The burrow entered the wood perpendicularly and led to an irregular series of tunnels, mostly formed by utilising the old galleries of other insects. A cell near the entrance contained 22 *Typhlocyba ulmi*, L.; another—6 *T. ulmi*, L., and a larva of the wasp; a third—a pupa of the wasp and 4 uneaten *T. ulmi*, L.

In the present paper 569 specimens of prey are recorded, of which 202 are ♂ and 367 are ♀. Nearly all the records were made by A. H. Hamm from two colonies, one in the New Forest and one in a garden at Oxford. Both were in rotten wood of about the consistency of firm cheese, and not so soft as the final product of decay, viz. "touchwood." In the New Forest the colony was in an old beech-stump, at Oxford in an elm-trunk lying on the ground. The nests were of the second type with most of the side-passages containing the cells given off towards the end of the main burrow. In both, the entrances were close to the ground-level.

In the New Forest oak-feeding leaf-hoppers were in the majority, *Alebra* being the commonest, although *Typhlocyba quercus*, F., was by no means rare. At Oxford the latter was much the commonest species among the prey, in

spite of the fact that no oak-tree grew very near the colony, while near at hand were plenty of elms, which must have been swarming with leaf-hoppers.

The three cells of one individual in the Oxford colony were peculiar in that the prey, except for a single specimen of *Psylla* sp., consisted entirely of an undetermined species of *Typhlocyba*. Except for the one Psyllid the whole of the prey in both colonies belonged to the TYPHLOCYBIDAE.

The number of the prey in each cell was as follows :—New Forest (9 Aug. 1908) one cell of 9, three of 12, one of 14.

New Forest (15 Aug. 1908) two cells of 9, two of 10, five of 11, one of 13.

Oxford (15 July, 1912) one cell of 11, one of 12, one of 14, one of 16, two of 17, five of 18, one of 22.

Oxford (27 July, 1912) one cell of 9, one of 10, one of 14, two of 15, one of 18, two of 19, one of 22. Furthermore one wasp had 3 cells of 12, 17, and 20, respectively. In the New Forest, where the large *Alebra* was the commonest prey, the average number was fewer than at Oxford.

An interesting fact was discovered concerning the biology of the prey. These TYPHLOCYBIDAE are much parasitised, either by Pipunculid flies, perhaps of the genus *Chalarus*, or more probably by the Hymenopterous genus *Aphelinus* (DRYINIDAE). When the prey has died the parasitic larva forces its way out and can be seen protruding from the dry preserved specimens. In the New Forest there were only 9 of the prey thus infected out of a total of 185. In the Oxford colony, however, on 15 July, 1912, 137 out of 207 were infected, and on 27 July, 13 out of 202. On the second date the parasitic larvae were mostly larger and in one case had definitely left for pupation; hence, at this later date parasitised individuals were probably less easy for the wasps to find, a large proportion having been killed by the emergence of the parasite. The infected individuals are doubtless somewhat less active and thus more easily caught, and such destruction of infected individuals which must in any case perish, would be beneficial to the species. In the list of prey a number followed by the letter P is used to indicate the number of individuals parasitised.

18. **Blepharipus walkeri,** Shuck. Kohl 1915, p. 413 (*aphidum*, Lep., Perkins 1913).

The only record of habits which is certainly applicable to this species is that of Nielsen (Kohl 1915). The nests were found in broken branches of beech and elder. The main burrow has a diameter of 3–3½ mm. and gives off short side-passages in all directions, leading to the cells. The main passage itself may often be forked. The prey consisted entirely of the mayfly *Chloëon* [*Chloë*] *dipterum*, L., mostly ♂♂ and usually three to a cell. The front legs were always, and the other pairs generally, bitten off at the coxae.

19. **Blepharipus carbonarius,** Dahlb. Kohl 1915, p. 414.

Bold (Kohl 1915) states that this species preys on a small bright-green fly, but his identification of the wasp must be considered very uncertain.

Adlerz (Kohl 1915) in Sweden found the species nesting commonly in the trunks of *Picea* in the larval galleries of other insects. Every four or five minutes a wasp would arrive with a small fly. In this species the burrow when fully stored is filled with pieces of wood and bark, and not left open as in many Crabros. In one cell 17 small flies (unidentified) were all motionless, while in another some of them moved their legs slightly. The egg was found on a fly lying at the outer end of the store.

20. **Ablepharipus podagricus,** V. d. Lind. Kohl 1915, p. 415.

Roman (Kohl 1915) found a nest in the branch of an oak-tree. It was a long simple burrow in the old gallery of some other insect. The prey consisted of both sexes of a small *Chironomus*. When the nest was completed the outer part of the burrow was filled with wood chips.

Prey here recorded includes 19 specimens—7 ♂ and 12 ♀. They consist mainly of SCATOPSIDAE; but there are also a few Ceratopogines and two *Oscinis*.

At Shotover near Oxford the species was found by A. H. Hamm nesting in a post with *Pemphredon lugubris*, Latr. An attempt was made to determine the time spent in hunting for prey, but observation was very difficult owing to the quick movement of both species nesting in the post. The following notes were made on a female *podagricus* :—

Arrived with prey	12.32 p.m. :	remained in burrow 1½ min.
,, ,, ,,	12.36 ,, :	,, ,, ,, 13 sec.
,, ,, ,,	12.46 ,, :	,, ,, ,, 55 sec.
,, ,, ,,	12.51 ,, :	The wasp captured.

21. **Crossocerus palmarius,** Schreb. Kohl. 1915, p. 415.

Nielsen (Kohl 1915) observed this wasp from June to August in sandy places in Denmark. A nest, excavated in the ground, consisted of a short tunnel with a cell at the end containing three flies—*Helina* [*Spilogaster*]? *impuncta*, Zett., 1 ♂, and *Spilogaster duplicata*, Mg., 2 ♂.

We record 8 specimens of prey—1 ♂ and 7 ♀. At Lye Hill near Oxford the wasp was found by A. H. Hamm burrowing in hard sandy ground at the side of a path amongst the stalks of wheat (5 August, 1909).

22. **Crossocerus palmipes,** L. Kohl 1915, p. 415.

Hardly anything is recorded of the habits of this species on the continent. In this paper 50 specimens of prey are recorded—13 ♂ and 37 ♀. The species was found (A. H. H.) nesting gregariously in abundance in various parts of the University Museum grounds at Oxford. The nests were either in the soil or in the mortar between the courses of the stone walls. The wasp, when returning with prey, dives straight into the nest without hesitation. A nest in rather damp sandy soil excavated near Kirtlington, Oxon., consisted of a burrow about two inches long ending in a small cell (O. W. R.). This nest, however, was probably only in the early stages of construction. The parasitic Mutillid *Myrmosa melanocephala*, F., was seen just outside the burrows of this species in the Museum grounds at Oxford (A. H. H.).

23. **Crossocerus varius,** Lep. Kohl 1915, p. 416.

Ferton (Kohl 1915) found a nest in the ground on a sunny slope at Bonifacio (21 October). The tunnel was short and there were only two cells, one of which was completely provisioned and contained a young larva and 14 *Tachydromia articulata*, Mcq.

Adlerz (Kohl 1915) found the nests in a hard, trodden path in a park in Sweden. They formed a small colony indicated by the little piles of excavated sand. The tunnel usually enters the ground somewhat obliquely, but changes to a perpendicular direction. The few cells all open into the main tunnel and are situated 2·5–3 cm. beneath the surface of the ground. The prey consisted

of various small flies including Nematocera and there were usually seven in a cell. Six or seven species of prey may be stored in a single nest. Adlerz also describes a second colony nesting in a hard path and preying mainly on TIPULIDAE.

24. **Crossocerus anxius,** Wesm. Kohl 1915, p. 416 (*ovalis*, Lep., Perkins 1913).

Kohl (1915) found this wasp nesting in sand and preying on *Tachista arrogans*, L., ♀. Borries (Kohl 1915) found the nest in a sandy bank. The tunnel took a curved course on entering the bank and ended in a cell containing two *Tachydromia pallidiventris*, Mg. Adlerz (Kohl 1915) found this species in Sweden, on two different occasions, nesting in hard, sandy paths. The tunnel went down perpendicularly for about 5 cm. and ended in a horizontal cell. The prey on both occasions consisted of Hemiptera, chiefly *Plagiognathus chrysanthemi*, Wolff—about five to a cell.

We here record 4 specimens of prey, all females, and it is curious to note that, in each of two widely separate localities, they belonged to the single species of fly *Tachydromia claranda*, Collin.

25. **Crossocerus wesmaeli,** V. de Lind. Kohl 1915, p. 417.

Adlerz (Kohl 1915) found this wasp nesting in sand and preying on Nematocera. The nest was very difficult to excavate owing to the great friability of the sand. The author also quotes from Aurivillius' "Svensk Insektfauna" (Abt. Hym., p. 146) a statement that the species preys on CHIRONOMIDAE and nests in wood, a site which, however, he regards as very improbable.

Smith (1858, p. 136) found the species in August at Lowestoft preying on flies of the genera *Notiphila* and *Phytomyza*. Pissot (1888) records the species as preying on *Typhlocyba rosae*, L., and *Chironomus* sp. Possibly, however, the *Crabro* with the first-mentioned prey was really another species (e.g. *B. ambiguus*, Dahlb); for errors are often made in the determination of the small black Crabros.

Hallett (1916) states that this species preyed exclusively on *Thereva annulata*, F., at Porthcawl. Ferton (1923, p. 89) records that *wesmaeli* stores paralysed *Oscinis*. Morley (1907, p. 83) states that the Ichneumon *Phygadeuon rugulosus*, Gr., is supposed to be associated with *C. wesmaeli*.

In the present paper 22 specimens of prey are recorded, 9 ♂ and 13 ♀. This wasp is very common on the Surrey heaths, nesting in the sand from July to September. The nests are most frequently excavated horizontally into perpendicular surfaces. The Dipterous prey is somewhat varied and mixed types may be stored in one nest.

26. **Crossocerus elongatulus,** v. de Lind. Kohl 1915, p. 418.

Wissmann (Kohl 1915) states that these wasps nest in sand, but also, especially the males, frequent old posts, etc. Sickmann (Kohl 1915) records that the species utilises the holes made by beetles in old posts and preys on the fly *Centor myopinus*, Lw.

Ferton (Kohl 1915) describes it as preying on *Sapromyza* sp. at Rognac. The wasps were taken by him (cf. Ferton 1923, p. 89) on the flowers of *Seseli tortuosum*. Ferton also gives two lists of the prey at Bonifacio, which, added together, are as follows:—*Agromyza cunctans*, Mg.; *A. gyrans*, Fall.; *A. pusilla*, Mg.; *Aphiochaeta* [*Phora*] *pulicaria*, Fall.; *Apodacra* sp.; *Cecidomyia*

sp.; *Chrysotus suavis*, Lw.; *Cyrtosia* sp.; *Dacus oleae*, Rossi; *Desmometopa m-nigrum*, Zett.; *Diastata obscurella*, Fall.; *Dohrniphora* [*Phora*] *concinna*, Mg.; *Ephygrobia compta*, Mg.; *Geron gibbosus*, Mg.; *Gymnosoma rotundatum*, L.; *Hecamede lateralis*, Lw.; *Medeterus flavipes*, Mg.; *Miltogramma* sp.; *Oscinis vindicata*, Mg.; *Paragus* sp., probably *bicolor*, F.; *Psilopus* sp.; *Scaptomyza* [*Drosophila*] *graminum*, Fall.; *Siphonella pumilionis*, Bjerz.; *Swammerdamella* [*Scatopse*] *brevicornis*, Mg.; *Syritta pipiens*, L.; *Tachydromia cothurnata*, Mcq.; *Toxophora maculata*, Wied.

V. R. Perkins (1892) records the species as preying on a very small black Dipteron, which may very probably have been an *Oscinis*.

We here record three specimens of prey—1 ♂ and 2 ♀.

Parasites—Baer (1921, p. 188) records *Macronychia polyodon*, Mg. The list of prey given by Ferton is very interesting, as it comprises a number of Diptera belonging to genera more or less associated with Hymenoptera, viz.—*Desmometopa m-nigrum*, Zett., *Apodacra* sp., *Miltogramma* sp., and *Paragus*. Ferton (1923, p. 118) states that the *Apodacra* was a parasite of *Chlorion* [*Sphex*] *albisectum*, Lep. et Serv. In some cases valuable hints as to the hosts of parasites of sand-wasps can be obtained by examining the lists of prey.

27. **Acanthocrabro vagabundus**, Pz. Kohl 1915, p. 397.

Sickmann (Kohl 1915) found this wasp nesting in an old spruce post in his garden. The nest was made in a hole from which a large nail had been extracted. The prey consisted of females of *Pachyrrhina iridicolor*, Schum., and *Tipula pruinosa*, Wied. The victims, after being paralysed with the sting, still retained some power of movement in the antennae. The front legs were then bitten off just below the coxae, and the mid and hind legs between the femur and trochanter.

Borries (Kohl 1915) found a nest in an old plum tree. The prey consisted of unidentified Diptera, all arranged with the head inwards. The nest was of the linear type and contained six cells. The ♂ cocoons were 9 × 3·5 mm. and the ♀ 12 × 4·5 mm. Jannson (1919) found this species in Sweden, entering a hole in a rotten poplar, and carrying a Tipulid with a black-marked thorax. The legs had been bitten off. He was unsuccessful in attempting to excavate this nest, but another was found which contained nothing but the remains of the same species of Tipulid. Fahringer (1922) found a nest near Constantinople in the burrow of the beetle *Ergatis faber*, L., in the trunk of *Pinus brutia*, L. The burrow had been closed with wood-dust. The remains of the prey appeared to belong to the genus *Pachyrrhina*. Bristowe (1925) mentions that this wasp is often seen carrying Tipulids at Wicken Fen.

In the present paper 2 ♂ and 2 ♀ Tipulids are recorded as prey. The females and one male had all the legs removed at the trochanter, the other male all except the right posterior.

28. **Cuphopterus serripes**, Pz. Kohl 1915, p. 396 (*dimidiatus*, Fab., Perkins 1913).

Kohl (1915) received a cocoon covered with remains, probably of Syrphids, and also grains of earth. Wissmann (Kohl 1915) bred a number of specimens from cocoons found in a much-eaten-out example of *Polyporus sulphureus* on oak. Brischke (Kohl 1915) found a nest in a rotten alder-stump. The remains of the prey belonged to the genera *Dolichopus*, *Leptis*, *Microchrysa* [*Chrysomyia*] and *Thereva*.

We here record two specimens of prey, both females.

29. **Cuphopterus signatus,** Pz.

The present paper appears to contain the only record of the habits of this species, viz. that it nested in the New Forest in very hard rotten wood and took as prey a male *Leptis tringaria*, L.

30. **Hoplocrabro quadrimaculatus,** Spin. Kohl 1915, p. 398.

Goureau (Kohl 1915), probably referring to this species, states that he found the nests in sand, the cells being 8–10 cm. underground. The prey was apparently always the males of the Leptid fly *Atherix ibis*, Mcq. Dahlbom (Kohl 1915) saw the wasp preying on *Fannia* [*Anthomyia*] *scalaris*, Mg., ♀.

Verhoeff (Kohl 1915) found the nests excavated, to a depth of 20–25 cm., in perpendicular surfaces of sand. At the end of each of three burrows were lying 5–6 dead but fresh *Culex pipiens*, L. The cell was not defined in any way, and many more *Culex* were lying near the entrance of the tunnel. He believed that the young are fed from day to day, but this conclusion is not supported by the notes of other observers.

Ferton (Kohl 1915) found the nests deep in sand at Bonifacio, and describes the pupa and cocoon. The prey consisted of *Culex* probably *pipiens*, L., ♂; *Fannia* [*Homalomyia*] *canicularis*, L.; *F.* [*H.*] *incisurata*, Zett.; *F.* [*H.*] *scalaris*, F.; *Helina* [*Spilogaster*] *quadrum*, F.; *Psilopus* sp.; *Sapromyza fasciata*, Fall.; *Spilogaster clara*, Mg.

Adlerz (Kohl 1915) also found the nest in similar vertical surfaces in Sweden. The adults occurred in July and August and there were probably two generations in a year. The prey were apparently for the most part Nematocera and the following could be identified :—1 ♂ *Anopheles bifurcatus*, L., 2 ♀ 7 ♂ *Rhyphus punctatus*, L.

Smith (1858, p. 143) records that this wasp preys on gnats and other small flies. C. Morley in a letter to Prof. Poulton writes that he found it preying on *Fannia* [*Homalomyia*] *scalaris*, F., on a sandy bank at Grundisburgh, Suffolk, 30 July, 1897. Halkyard (1923) found this wasp in Delamere Forest preying on *Leptis lineola*, F., *Rhyphus punctatus*, L., and *Sapromyza pallidiventris*, Fln. (all recorded as frequent prey in the present paper).

We here record 36 specimens of prey, including 13 ♂ and 22 ♀. In addition to Diptera this species also captures Lepidoptera and Trichoptera. Besides the two moths recorded as prey another was seen (A. H. H.), carried by a wasp which eluded capture. Most of the records are from a colony in the New Forest established in a perpendicular face of sandy earth produced by the uprooting of an old birch tree.

A specimen caught by A. H. Hamm in the New Forest was preying on *Hammomyia grisea*, Fln., a well-known parasite of bees and wasps.

31. ***Rhopalum tibiale,** F. Kohl 1915, p. 437.

Borries (Kohl 1915) found many nests in broken stems of raspberry in Denmark. The tunnel penetrates the stem for a distance of 8·5 to 40 cm. The cells (10–11 × 4·5–5 mm.) are broader than the tunnel, so that the nest as a whole is moniliform; in thinner stems, however, it may be linear. When the stems are thicker than usual, on the other hand, the nest may be of the second type with the cells opening almost directly into the main tunnel. The prey consisted of Nematocera—about 20 to a cell.

* Nothing in known of the habits of *Rhopalum kiesenwetteri*, Mor.

Schlectendal (Kohl 1915) found nests in old elder-twigs. The burrows formed a very elongate spiral. There were sometimes two nests in one stem. The prey observed were Nematocera. Nielsen (Kohl 1915) records that the moniliform nests may also be found in broken branches of oak and beech. One branch, a few centimetres in diameter, contained five nests. The prey consisted of Nematocera.

Wagner (Kohl 1915) found the nests in stems of *Sambucus racemosus*. The tunnel penetrated in an elongate spiral. The cells contained CHLOROPIDAE and also a few Aphids and one beetle (STAPHYLINIDAE). The cocoon has a double wall—an outer layer of whitish threads and within it a thicker tough layer of a yellowish colour. The cells were in niches in the wall of the main tunnel, their long axes at various angles with it. Berland (1925, p. 181) records that Giraud found a nest in rotten wood, stored with Chironomids and Tipulids.

Parasites—Nielsen (Kohl 1915) records *Diomorus armatus*, Boh.

32. **Physosceles clavipes,** L. Kohl 1915, p. 431.

Verhoeff (Kohl 1915) found the nests commonly in stems of *Rubus* and *Sambucus*. The nest may be definitely of the second type, linear, or intermediate. In the latter arrangement the cells bear the same relation to the main tunnel as that described in the last species. The prey consisted of Muscids and the larvae leave hardly any recognisable fragments of the hard parts. The cocoon is 2·5 × 7–8 mm. It has a double wall—an outer thinner web including remains of the prey and an inner denser and tougher layer. Two-thirds of the female wasps appear after the last male, and half the males before the first female.

Borries (Kohl 1915) found a nest in an ash-twig. The tunnel was 100 mm. long and 2·5 mm. wide. The nest was linear and contained eight cells of which all but the innermost (female) contained larvae which produced males. The prey belonged to the PSOCIDAE. Nielsen (Kohl 1915) also expressly states that every transition exists between nests of the first and those of the second type. A local thickening in the stem may contain a short side-passage leading from a nest which is otherwise of the linear type. The female-containing cells are, as a rule, the innermost, although nests have been found producing only males. The prey consisted of MYCETOPHILIDAE and CECIDOMYIDAE.

Bowman (Kohl 1915) found nests in old beetle-galleries in a plank; the prey here consisted of Nematocera. Another nest, in a stem of *Spiraea*, was stored with PSOCIDAE. Nests were also found in stems of hollow reeds. The largest of these included nine cells and they all contained *Psocus bifasciatus*, Latr. Two cells enclosed 2 adults with 9 larvae, and 7 adults with 2 larvae, respectively. There are probably two generations in a year.

Adlerz (Kohl 1915) found this wasp nesting in the straw of an old thatched roof and carrying prey which was probably a small yellow gnat. Alfken (Kohl 1915) records the species as preying on Aphides.

Billups (1883) bred this wasp amongst a number of other insects from the galls of *Cynips kollari*, Htg. Latter (1913) has seen it catching flies on window-panes. Malloch (1904) records that it nests commonly in Dumbartonshire in old walls. Perkins (1923) states that *clavipes* has been bred from bramble-stems near Plymouth. Picard (Berland 1925, p. 181) found the wasp nesting in the holes of beetles in the dead wood of fig-trees, and storing the fig Psyllid, *Homotoma ficus*, L.

In the present paper 4 adults of *Peripsocus subpupillatus*, Mcl., and 149 larvae, presumably of the same species, are recorded as prey. A nest was

found (A. H. H.) in a perpendicular surface of sand near Wellington College, Berks., 11 August, 1906. The nest, owing to the friable nature of the soil, could not be properly excavated, but there were presumably several cells.

Parasites—Borries (Kohl 1915) records *Diomorus armatus*, Boh. Box (1918) found two nests at Market Bosworth which he attributes to this species: they produced, however, only *Diomorus armatus*, Boh., the Chrysid *Ellampus* [*Homalus*] *auratus*, L., and an Ichneumonid.

33. **Lindenius albilabris,** F. Kohl 1915, p. 420.

Sickmann (Kohl 1915) states that the species nests in the earth and preys on *Diaphorus latifrons*, Lw. Nielsen (Kohl 1915) found about sixteen nests in a square yard of sand in Denmark. The entrance was surrounded by a small heap of sand. The tunnel descended 6–8 cm. vertically, then took a horizontal direction for 3 cm., and ended in a cell 6–8 mm. long. The prey consisted of the paralysed Hemipteron *Deraeocoris* [*Capsus*] *thunbergi*, Fall., of which 6–8 were stored in a cell. All the prey were adults.

Adlerz (Kohl 1915), who studied numerous colonies in Sweden, remarks that the nest is always left open except when excavation is actually in progress. At Sundvall the prey consisted entirely of flies. A few miles further south Hemiptera were the chief prey, although flies were also stored. In one colony every cell had a few flies and some had as many as 5–6, while in another colony several cells had no flies and the highest number of flies in any cell was three. The egg was always laid on a bug when Hemiptera were mixed with flies in a cell. Further south again, in Östergötland, Hemiptera alone were stored. These results were based on the examination of many nests. Full details of the investigation are given by Kohl (1915). The Hemiptera belonged to *Miris* and related genera, and 10–23 were stored in a cell.

Bowman (Kohl 1915) found the species in Holland storing its nest with *Globiceps flavomaculatus*, F. (1 adult and 4 nymphs), and *Miris calcaratus*, Tulb. (1 full-grown nymph and 4 younger ones). No flies were present.

We here record 82 examples of prey—80 Capsid bugs (19 ♂, 39 ♀, 22 young) and 2 ♀ Chloropid flies. It is interesting that these flies should be of the same type as those captured by the closest ally of this wasp. Some specimens of the recorded prey were not actually taken from wasps but found lying near the burrows. Probably when the wasp is disturbed, it is liable to drop its prey and would not retrieve it. The nest and nesting-site resemble those of the next species.

Parasites--Alderz (Kohl 1915) records that he found a *Myrmosa melanocephala*, F., in one nest, and the larva of a parasitic fly in another. Arnold (1906 and 1910) records the Chrysid *Hedychridium coriaceum*, Dahlb., as almost certainly a parasite, a conclusion confirmed by Mortimer (1913).

34. **Lindenius panzeri,** V. de Lind. Kohl 1915, p. 423.

Kohl (1915) found *L. panzeri* nesting in sandy places in N. Tirol and preying on *Carphotricha guttularis*, Mg. ♂. Marchal (Kohl 1915) found a nest in a hard-trodden garden path. The tunnel was narrow and deep and led to a cell containing a number of *Chloropisca* [*Chlorops*] *lineata*, F., which were probably dead. Sickmann (Kohl 1915) records *Carphotricha guttularis*, Mg., and *Simulium ornatum*, Mg., as prey.

Bowman (Kohl 1915) found the nests in hard ground. The burrow entered the ground perpendicularly for 10 cm., and here, in the same horizontal plane,

were five cells at the end of side-passages, and in another parallel plane at a higher level four more passages with cells. The prey, 22 to a cell, was *Chlorops hypostigma*, Mg. A single cell enclosed also one specimen of *Tephritis* sp. Other nests were found on a much simpler plan and sometimes consisting of only two cells.

In the present paper 87 Chloropids are recorded as prey—85 ♂ and 2 ♀. Male CHLOROPIDAE are known to have a curious dancing flight (probably connected with mating), and it is possible, although there is no direct evidence for this, that the prey is chiefly caught on the wing. The nesting-site, both in the New Forest and on Esher Common, was a hard sand path (A. H. H.). The burrow was externally indistinguishable from that of *L. albilabris*, F. Over the entrance was a small mound of excavated sand, in the centre of which was the little countersunk crater leading to the tunnel.

35. **Entomognathus brevis,** V. de Lind. Kohl 1915, p. 426.

Sickmann (Kohl 1915) states that this species nests in the earth and preys on small flies. Adlerz (Kohl 1915) found it nesting in the earthy gravel dug out of a ditch, and capturing the beetle *Longitarsus luridus*, Scop. Smith (1849) and Berland (1925, p. 176) describe this wasp as preying on HALTICIDAE.

We here record 15 specimens of prey—all phytophagous beetles.

PART III. THE LIST OF PREY.

In the following list the locality and date of the observation are given in the left-hand column; in the next column the name of each species of prey with the number and sex of the specimens. Unless otherwise stated each specimen was taken from a different wasp or from the same wasp on different occasions. In large colonies the exact details of the prey of each individual wasp are sometimes difficult to observe. In the third column are given the initials of the authority who determined the prey. The names with initials will be found in the Introduction. In the right-hand column are additional notes and also the name of the observer, it being understood that when no name is mentioned the observer was A. H. Hamm.

LOCALITY AND DATE.	SPECIES AND SEX OF PREY.	IDENTIFIER.	NOTES, AND OBSERVER WHEN NOT A.H.H.
	Clytochrysus zonatus, Pz.		
	Diptera.		
Lyme Regis, Dorset. 21 July.	*Catabomba pyrastri*, L., ♀.	O.W.R.	E. B. Nevinson.
	Clytochrysus cavifrons, Thoms.		
	Diptera.		
Shotover, Oxford. 28 July, '06.	*Platychirus peltatus*, Mg., ♀.	J.W.Y.	
Bayswater, Headington, Oxon. 16 Aug., '15.	*Platychirus albimanus*, F., ♂. *P. albimanus*, F. (melanic var.), ♀. *Syrphus corollae*, F., ♀. *S. latifasciatus*, Mcq., ♂.	O.W.R. J.E.C. O.W.R. O.W.R.	
The same. 14 Aug., '15.	*S. latifasciatus*, Mcq., ♂.	O.W.R.	Specimen lying outside burrow.
Garden, Cowley Road, Oxford. 21 July, '12.	*Syrphus corollae*, F., ♂.	J.E.C.	
Thame, Oxon. 5 Aug., '15.	*Syrphus balteatus*, Deg., 2 ♀. *S. latifasciatus*, Mcq., ♂.	O.W.R. O.W.R.	H. Britten. " "
Sindlesham, near Reading, Berks. 30 July, '06.	*Calliphora erythrocephala*, Mg., ♂. *Lucilia caesar*, L., 3 ♀.	C.J.W. C.J.W.	 The specific name is doubtful.

Locality and Date.	Species and Sex of Prey.	Identifier.	Notes, and Observer when not A.H.H.
Queen's Bower, New Forest, Hants. 9 Aug., '08.	*Syrphus auricollis*, Mg., var. *maculicornis*, Ztt., ♂.	C.J.W.	
	S. balteatus, Deg. Fragment.	C.J.W.	
	S. ribesii, L., 3 ♂.	C.J.W.	All 8 from one
The same. 15 Aug., '08.	*Chrysops caecutiens*, L., ♂.	C.J.W.	burrow.
Wicken Fen, Cambs. Aug., 1912.	*Syrphus balteatus*, Deg. Fragment.	O.W.R.	C. J. C. Pool.
	Syrphus spp. Fragments.	O.W.R.	" "
Upper Sapey, Worcester. 25–8 Aug., '22.	*Syrphus vitripennis*, Mg., ♂.	O.W.R.	E. B. Nevinson.
Criccieth, Carnarvon. July, 1897.	*S. balteatus*, Deg., ♂.	O.W.R.	E. B. Nevinson.
	S. latifasciatus, Mcq., ♂.	O.W.R.	" "
	Clytochrysus chrysostomus, Lep.		
	Diptera. (Syrphidae.)		
Wroxham, Norfolk. 5 Sept., '02.	*Platychirus manicatus*, Mg., 4 ♀.	J.W.Y.	Three of the wasps
	P. peltatus, Mg., ♀.	J.W.Y.	bred by G. A. K.
	P. scutatus, Mg., 4 ♀.	J.W.Y.	Marshall. Some of
	Sphaerophoria menthastri, L., 2 ♀.	J.W.Y.	the prey kept.
	Solenius vagus, L.		
	Diptera.		
Southfield Rd., Oxford. 1 Aug., '08.	*Eriothrix rufomaculata*, Deg., 3 ♂.	O.W.R.	C. H. Hamm.
	Eristalis arbustorum, L., ♂.	O.W.R.	" "
Wicken Fen, Cambs. 28 Aug., '12.	*Calliphora* sp. Fragment.	O.W.R.	
	Chrysogaster sp. Fragment, ♂.	O.W.R.	
	Chrysops relicta, Mg., ♂.	O.W.R.	
	Eristalis sp. Fragment.	O.W.R.	Cell contents taken
	Leptis scolopacea, L. At least 10.	O.W.R.	from rotten wood
	Melanostoma sp., 2.	O.W.R.	by C. J. C. Pool.
	Muscid sp., 9.	O.W.R.	All very frag-
	Muscid, another sp., 1.	O.W.R.	mentary.
	Sargus prob. *cuprarius*, L., 1.	O.W.R.	
	Syrphus balteatus, Deg., 2 ♀, 1 ♂, 2 ?.	O.W.R.	
	Syrphid sp., 2.	O.W.R.	
	Tachinid sp., 1.	O.W.R.	
	Metacrabo quadricinctus, F.		
	Diptera.		
Greenham Common, Newbury, Berks. 16 Aug., '18.	*Calliphora erythrocephala*, Mg., 4 ♂, 5 ♀.	O.W.R.	
	C. vomitoria, L., ♂.	O.W.R.	
	Helina (Mydaea) impuncta, Fall., ♀.	J.E.C.	
	Lucilia flavipennis, Kram., 2 ♂.	O.W.R.	See Richards (1926).
	Lucilia caesar, L., 1 ♂.	O.W.R.	See Richards (1926).
	Mesembrina meridiana, L., ♀.	O.W.R.	
	Morellia sp., 2 ♀.	O.W.R.	
	Musca corvina, F. (*autumnalis*), 1 ♀.	O.W.R.	
	Muscina pabulorum, Fln., 2 ♀.	O.W.R.	
	M. stabulans, Fln., 2 ♂, 1 ♀.	O.W.R.	
	Mydaea urbana, Mg., ♂.	J.E.C.	
	Onesia [*aculeata*, Pand.], 8 ♂, 1 ♀.	O.W.R.	Named *sepulchralis*,
	Phaonia basalis, Ztr., ♀.	J.E.C.	Mg.? by J.E.C.
	Ph. errans, Mg., ♂.	J.E.C.	According to
	Ph. erratica, Fln., ♂.	J.E.C.	Stein's recent key
	Ph. signata, Mg., 3 ♂, 2 ♀.	J.E.C.	the species seems,
	Ph. variegata, Mg., ♀.	J.E.C.	however, to be
	Platychira (*Erigone*) *radicum*, F., ♂.	O.W.R.	*aculeata*, Pand.
	Polietes lardaria, F., 14 ♂, 9 ♀.	O.W.R.	
	Sarcophaga, sp., 2 ♀.	O.W.R.	
	Syrphus ribesii, L., 7 ♂, 2 ♀.	O.W.R.	
The same place. 19 Aug., '18.	*Calliphora erythrocephala*, Mg., 2 ♂, 3 ♀.	O.W.R.	
	C. vomitoria, L., 2 ♂.	O.W.R.	
	Catabomba pyrastri, L., ♀.	O.W.R.	
	Helina anceps, Ztt., ♂.	J.E.C.	
	Lucilia caesar, L., 3 ♂.	O.W.R.	See Richards (1926).
	L. simulatrix, Pand., ♂.	O.W.R.	See Richards (1926).
	L. sp., 2 ♀.	O.W.R.	
	Musca corvina, F. (*autumnalis*), ♀.	J.E.C.	
	Muscina pabulorum, Fln., 1 ♂, 1 ♀.	O.W.R.	
	M. stabulans, Fln., ♀.	O.W.R.	
	Mydaea detrita, Ztt. (*affinis*, Mde.), ♂.	J.E.C.	
	Onesia [*aculeata*, Pand.], 1 ♂, 1 ♀.	O.W.R.	See note above.
	Phaonia errans, Mg., ♀.	J.E.C.	
	Ph. erratica, Fall., ♀.	J.E.C.	
	Ph. signata, Mg., ♀.	J.E.C.	
	Polietes lardaria, F., 8 ♂., 4 ♀.	O.W.R.	
	Pollenia rudis, F., ♀.	O.W.R.	
	Syrphus albostriatus, Fln., ♀.	O.W.R.	
	S. luniger, Mg., ♂.	O.W.R.	
	S. ribesii, L., 3 ♂.	O.W.R.	
	S. vitripennis, Mg., ♂.	O.W.R.	

Locality and Date.	Species and Sex of Prey.	Identifier.	Notes, and Observer when not A.H.H.
Queen's Bower, New Forest, Hants. 9 Aug., '08.	*Mesembrina meridiana*, L., ♂.	C.J.W.	
	Onesia sepulchralis, Mg., ♀.	C.J.W.	[? really *O. aculeata*, Pand. O.W.R.]
	Pollenia rudis, F., ♂.	C.J.W.	
	Tabanus bromius, L., ♀.	C.J.W.	
	T. glaucus, Mg. (? var. of *bromius*), 2 ♂.	C.J.W.	
The same. 15 Aug., '08.	*Machimus atricapillus*, Fln., ♀.	C.J.W.	
	Myiocera carinifrons, Fln., ♂.	C.J.W.	
	Onesia aculeata, Pand. ?, ♀.	O.W.R.	
	Phaonia querceti, Bouché, ♂.	J.E.C.	
	Pollenia rudis, F., 2 ♂.	C.J.W.	
	Protocalliphora azurea, Fln., ♀.	C.J.W.	
	Sarcophaga carnaria, L., ♂.	C.J.W.	
	Tabanus bromius, L., ♀.	C.J.W.	
The same. 9 Aug., '09.	*Leptis scolopacea*, L., ♂.	C.J.W.	
	Phaonia scutellaris, Fln., ♂.	C.J.W.	
	Polietes lardaria, F., ♀	C.J.W.	
Upper Sapey, Worc. 25–8 Aug., '22.	*Calliphora erythrocephala*, Mg., ♂, ♀.	O.W.R.	E. B. Nevinson.
	Hydrotaea irritans, Fln., ♀.	J.E.C.	
	Phaonia signata, Mg., 2 ♀.	J.E.C.	
	Polietes lardaria, F., ♂.	O.W.R.	
	Pollenia rudis, F., 2 ♀.	O.W.R.	
Metacrabro lituratus, Pz.			
Dawlish, S. Devon. July, '09.	Anthomyiidae or Cordyluridae fragments.	O.W.R.	
Thyreopus cribrarius, F.			
	Diptera		
Hogley Bog, Oxon. 8 July, '06.	*Thereva nobilitata*, F., ♂	J.W.Y.	
The same. 14 July, '07	*Th. nobilitata*, F., ♂.	C.J.W.	
The same. 3 Aug., '09.	*Onesia coerulea*, Mg., ♂	O.W.R.	
	Pollenia rudis, F., 1 ♂, 1 ♀.	C.J.W.	
The same. 4 Aug., '09.	*Pollenia rudis*, F., 5 ♂, 3 ♀.	C.J.W.	
	Thereva nobilitata, F., ♀	C.J.W.	
The same. 5 Aug., '09.	*Pollenia rudis*, F., 1 ♂, 1 ♀.	C.J.W.	
The same. 6 Aug., '09.	*Thereva bipunctata*, Mg., ♀.	C.J.W.	
	Th. nobilitata, F., ♂.	C.J.W.	
Tubney, Berks. 4 Aug., '09.	*Pollenia rudis*, F., ♂.	C.J.W.	
	Tabanus bromius, L., ♀.	C.J.W.	
The same. 1 Aug., '10.	*Morellia hortorum*, Fln., ♂.	J.E.C.	
Wellington College, Berks. 9 Aug., '06.	*Syritta pipiens*, L., ♂.	J.W.Y.	
Lyndhurst, New Forest, Hants. 5 Aug., '09.	*Thereva nobilitata*, F., ♀.	C.J.W.	G. Arnold.
Denny Bog, New Forest, Hants. 8 Aug., '09.	*Machimus atricapillus*, Fln., ♂.	J.W.Y.	
Brodie, Nairnshire. 18 July, '04.	*Calliphora vomitoria*, L., ♀.	J.W.Y.	J. W. Yerbury.
Bude, N. Cornwall. No date.	*Empis tessellata*, F., ♂.	O.W.R.	E. B. Nevinson.
Thyreopus peltarius, Schreb.			
	Diptera.		
Hogley Bog, Oxon. 14 July, '07.	*Helina quadrum*, Fall., ♂.	C.J.W.	
	Hylemyia brassicae, Bouché, ♂.	J.E.C.	
	Rhinophora lepida, Mg., ♀.	C.J.W.	
	Thereva nobilitata, F., ♂.	C.J.W.	
Shotover, Oxon 11 June, '09.	*Thereva plebeia*, L., ♂.	G.H.V.	
The same. 19 June, '10.	*Helina quadrum*, Fall., ♂.	J.E.C.	
	Microchrysa polita, L., ♀.	O.W.R.	
The same. 28 July, '17.	*Hydrotaea irritans*, Fln., ♂.	O.W.R.	

Locality and Date.	Species and Sex of Prey.	Identifier.	Notes, and Observer when not A.H.H.
	Thyreopus scutellatus, F.		
	Diptera (Dolichopodidae).		
Denny Bog, New Forest, Hants. 3 Aug., '07.	*Dolichopus atratus*, Mg., 5 ♀.	J.R.M.	In one cell.
	D. vitripennis, Mg., ♀.	J.R.M.	
	Gymnopternus aerosus, Fln., ♀.	J.R.M.	
	Porphyrops, sp., ♀.	J.R.M.	
	Dolichopus vitripennis, Mg., ? sex.	J.R.M.	
The same. 10 Aug., '08.	*D. atripes*, Mg., ♀.	J.R.M.	In one cell.
	D. andalusiacus, Strobl, ♀.	J.R.M.	
	D. atripes, Mg., 16 ♀.	J.R.M.	
	D. vitripennis, Mg., 2 ♀.	J.R.M.	
	D. atripes, Mg., 17 ♀.	J.R.M.	In one cell.
	D. vitripennis, Mg., ♀.	J.R.M.	
	D. atripes, Mg., 5 ♀.	J.R.M.	In one cell.
	D. vitripennis, Mg., 13 ♀.	J.R.M.	
The same. 14 Aug., '08.	*D. atripes*, Mg., 4 ♀.	J.R.M.	In one cell.
	D. vitripennis, Mg., ♀.	J.R.M.	
	D. vitripennis, Mg., ♀.	J.R.M.	Wasp caught with this owned the next three cells.
	D. atripes, Mg., 7 ♀.	J.R.M.	In one cell.
	D. vitripennis, Mg., 2 ♀.	J.R.M.	
	D. atripes, Mg., 7 ♀.	J.R.M.	In one cell.
	D. vitripennis, Mg., 3 ♀.	J.R.M.	
	D. sp., 1 fragment.	J.R.M.	
	D. atripes, Mg., 10 ♀.	J.R.M.	In one cell.
	D. vitripennis, Mg., 4 ♀.	J.R.M.	
The same. 8 Aug., '09.	*D. atripes*, Mg., 2 ♀.	J.R.M.	In one cell.
	D. plumipes, Scop., ♀.	J.R.M.	
	D. vitripennis, Mg., 8 ♀.	J.R.M.	
	D. atripes, Mg., 2 ♀.	J.R.M.	
	D. atratus, Mg., ♀.	J.R.M.	
	D. vitripennis, Mg., 4 ♀, 1 ♂.	J.R.M.	
	Dolichopodid fragments, 1 spec.	J.R.M.	
	Gymnopternus aerosus, Fall., 2 ♂, 1 ♀.	J.R.M.	
	Poecilobothrus nobilitatus, L., ♀.	J.R.M.	
	D. atratus, Mg., ♂.	J.R.M.	Wasp caught with this owned the next three cells.
	D. atripes, Mg., 16 ♀.	J.R.M.	In one cell.
	D. vitripennis, Mg., ♀.	J.R.M.	
	D. atripes, Mg., 9 ♀.	J.R.M.	In one cell.
	D. picipes, Mg., ♀.	J.R.M.	
	D. vitripennis, Mg., 2 ♀.	J.R.M.	
	D. sp. fragments, at least 6..	J.R.M.	
	D. atripes, Mg., 3 ♀.	J.R.M.	In one cell.
	D. vitripennis, Mg., 4 ♀.	J.R.M.	
	D. sp. fragments, at least 6.	J.R.M.	
	Blepharipus leucostomus, L.		
	Diptera.		
Southfield Rd., Oxford. 9 June, '12.	*Egle radicum*, L., ♀.	J.E.C.	
Shotover, Oxford. 5 Sept., '15.	*Hylemyia fugax*, Mg., ♂.	J.E.C.	
Bayswater, Headington, Oxon. 16 Aug., '15.	*Baccha elongata*, F., ♂.	O.W.R.	
	Helina communis, Dsv., ♂.	J.E.C.	
	Hydrotaea meteorica, L., ♀.	J.E.C.	
	Meigenia floralis, Mg., ♂.	J.E.C.	
	Melanostoma mellinum, L., 2 ♂.	O.W.R.	
	Platychirus albimanus, F., 2 ♂.	O.W.R.	
	Pollenia rudis, F., ♀.	O.W.R.	
Queen's Bower, New Forest, Hants. 10 Aug., '14.	*Chlorops taeniopus*, Mg., ♀.	J.E.C.	Only some of these *Coenosia* were determined by J.E.C., others by O.W.R.
	Chrysotus gramineus, Mg., ♀.	J.E.C.	
	Coenosia lineatipes, Zett., 13 ♂, 5 ♀.	J.E.C.	
	Dolichopus atripes, Mg., ♂.	O.W.R.	
	Fannia polychaeta, Stein, ♀.	J.E.C.	
	Hilara litorea, Fall., ♂.	J.E.C.	
	Lauxania amica, Hal., ♂.	J.E.C.	
	Leptis lineola, F., 2 ♀.	O.W.R.	
	Plesina maculata, Fall., ♀.	J.E.C.	
	Pseudocoenosia abnormis, Stein, ♀.	J.E.C.	
	Sapromyza difformis, Lw., ♂.	J.E.C.	
	Xanthochlorus ornatus, Hal., ♂.	O.W.R.	

LOCALITY AND DATE.	SPECIES AND SEX OF PREY.	IDENTIFIER.	NOTES, AND OBSERVER WHEN NOT A.H.H.
Lyme Regis, Dorset. No date.	*Hebecnema umbratica*, Mg., ♂.	J.E.C.	
	Hydrotaea armipes, F., ♂.	O.W.R.	E. B. Nevinson.
	Platychirus albimanus, F., ♂, ♀.	O.W.R.	
Relubbus, West Cornwall. 26 July, '25.	*Beris vallata*, Forst., ♂.	O.W.R.	All these specimens taken from the cells of a colony in a log by O.W.R.
	Chorisops tibialis, Mg., 5 ♂, 6 ♀.	O.W.R.	
	Chortophila trichodactyla, Rdi., ♂.	J.E.C.	
	Chrysotimus molliculus, Fln., ♀.	O.W.R.	
	Coenosia sp., ♀.	J.E.C.	
	Fannia armata, Mg., ♂.	J.E.C.	
	F. kowarzi, Verr., ♀.	J.E.C.	
	F. manicata, Mg., 3 ♂.	J.E.C.	
	F. polychaeta, Stein, 1 ♂, 1 ♀.	J.E.C.	
	F. similis, Stein, ♂.	J.E.C.	
	Hybos culiciformis, F., ? sex.	O.W.R.	
	Hydrotaea albipunctata, Ztt., ♂.	J.E.C.	
	H. irritans, Fln., 3 ♂, 1 ♀.	J.E.C.	
	Lonchaea vaginalis, Fall., 1 ♂, 4 ♀.	J.E.C.	
	Microchrysa flavicornis, Mg., 10 ♂, 6 ♀.	O.W.R.	
	M. polita, L., 8 ♂, 11 ♀.	O.W.R.	
	Oedoparaea buccata, Fall, ♂.	J.E.C.	
	Oxycera pulchella, Mg., 3 ♂, 5 ♀.	O.W.R.	
	Phytomyptera nitidiventris, Rdl., ♀.	J.E.C.	
	Sargus probably *minimus*, Ztt., ♀.	J.E.C.	
	Sciapus platypterus, F., ♀.	O.W.R.	
	Sepsis cynipsea, L., 1 ♂, 1 ♀.	J.E.C.	
	S. nigripes, Mg., ♂.	J.E.C.	
	Simulium aureum, Fries., ♂.	F.W.E.	
	Tachydromia pallidiventris, Mg., ♀.	J.E.C.	
	Trichina clavipes, Mg., ♂.	O.W.R.	
	Verrallia aucta, Fln., ♂.	O.W.R.	
	Hymenoptera.		
	Lygaeonematus or *Pachynematus* sp. fragment, ♂.	O.W.R.	
	Blepharipus capitosus, Shuck.		
	Diptera.		
Bagley Wd., Berks. Dec., '24.	*Tachydromia* spp. fragments, at least 9.	O.W.R.	O.W.R. Fragments in cell in stem of elder.
The same. Dec., '24.	Stratiomyid, metallic sp., fragment.	O.W.R.	O.W.R. Fragments in cell in stem of ash.
	Tachydromia, spp. fragments, at least 3.	O.W.R.	
The same. Feb., '26.	*Rhamphomyia* sp., 1 ♂, 1 ♀.	O.W.R.	One cell. O.W.R. Nest of 7 cells in ash-stem.
	Phytomyza sp., 3.	O.W.R.	
	Rhamphomyia sp., at least 9.	O.W.R.	One cell.
	R. sp. fragments.	O.W.R.	One cell.
	R. sp. fragments.	O.W.R.	One cell.
	Dolichopodid fragment.	O.W.R.	One cell.
	Chironomid sp., 2 ♂.	O.W.R.	One cell.
	Dolichopodid sp., 2	O.W.R.	
	Limnobiid sp., 1 ♀.	O.W.R.	
	Rhamphomyia sp., at least 1.	O.W.R.	
	Homoptera.		
The same. 29 April, '26.	? *Aphalara nebulosa*, Ztt., fragments.	O.W.R.	O.W.R. Nest of 5 cells in ash-stem.
	Psyllid sp., fragments.	O.W.R.	
	Diptera.		
S. Hinksey, Berks. 28 Jan., '26.	*Tachydromia* spp., fragments, at least 20 ♂, 24 ♀, 2 ?.	O.W.R.	O.W.R. Almost certainly this species: cells in elder-stem.
University Museum grounds, Oxford. 4 April, '23.	*Pachygaster atra*, Pz., fragment, 2.	O.W.R.	Cells in *Rhus coriaria* stems.
	Tachydromia spp., fragments.	O.W.R.	
	Homoptera.		
	Psylla sp., at least 3.	O.W.R.	

Blepharipus ambiguus, Lep.

Homoptera.

P = Parasite. In all cases the sexes and the occurrence of parasites have been determined by O.W.R.

Queen's Bower, New Forest, Hants. 30 July, '07.	*Alebra albostriella*, Fall., 4 ♂, 4 ♀.	E.A.B.	In one cell.

Locality and Date.	Species and Sex of Prey.	Identifier.	Notes, and Observer when not A.H.H.
The same. 9 Aug., '08.	*Alebra albostriella*, Fall., ♂.	E.A.B.	
	A. albostriella, Fall., 10 ♂, 2 ♀.	E.A.B.	Wasp carrying this owned 2 cells below with 12 and 9 victims.
	A. albostriella, Fall., 1 ♂, 8 ♀.	E.A.B.	
	A. albostriella, Fall., 4 ♂, 7 ♀.	E.A.B.	In one cell. 1 P.
	Eupteryx concinna, Germ., ♀.	E.A.B.	
	Typhlocyba quercus, F., ♂.	E.A.B.	
	T. tenerrima, H-S., ♀.	E.A.B.	
	Alebra albostriella, Fall., 3 ♀.	E.A.B.	In one cell. These two from one burrow.
	Eupteryx concinna, Germ., 6 ♂.	E.A.B.	
	Typhlocyba quercus, F., 3 ♂.	E.A.B.	
	Alebra albostriella, Fall., 12 ♀.	E.A.B.	In one cell.
The same. 15 Aug., '08.	*Alebra albostriella*, Fall., 2 ♀, 1 ♂.	E.A.B.	
	Eupteryx concinna, Germ., ♂.	E.A.B.	The wasp carrying this owned the following cell.
	A. albostriella, Fall., 2 ♂, 7 ♀.	E.A.B.	
	Eupteryx concinna, Germ., ♀.	E.A.B.	In one cell. 1 P.
	Typhlocyba tenerrima, H-S., ? sex.	E.A.B.	
	Alebra albostriella, Fall., 4 ♀.	E.A.B.	Part of a cell.
	A. albostriella, Fall., 3 ♂, 3 ♀.	E.A.B.	In one cell. 1 P. These two from one burrow.
	Eupteryx concinna, Germ., ♂.	E.A.B.	
	E. pulchellus, Fall., ♀.	E.A.B.	
	Typhlocyba quercus, F., 2 ♀.	E.A.B.	
	Alebra albostriella, Fall., 4 ♂, 2 ♀.	E.A.B.	In one cell.
	Eupteryx concinna, Germ., 3 ♂.	E.A.B.	
	Typhlocyba quercus, F., ? sex.	E.A.B.	
	Alebra albostriella, Fall., ♀.	E.A.B.	
	Eupteryx concinna, Germ., ♀.	E.A.B.	
	Typhlocyba douglasi, Edw., 1 ♂, 6 ♀.	E.A.B.	In one cell. 2 P.
	T. gratiosa, Boh., 1 ♂, 2 ♀.	E.A.B.	
	T. sp., ♀.	E.A.B.	
	Zygina alneti, Dahl., ♀.	E.A.B.	Wasp caught with this owned this cell. 1 P.
	Typhlocyba douglasi, Edw. ?, 1 ♂, 3 ♀.	E.A.B.	
	Alebra albostriella, Fall., 2 ♂, 3 ♀.	E.A.B.	
	Typhlocyba gratiosa, Boh., ♂.	E.A.B.	
	T. quercus, F., ? sex.	E.A.B.	In one cell.
	T. rosae, L. ?, 2 ♀.	E.A.B.	
	Typhlocybid sp., 2.	E.A.B.	
	Alebra albostriella, Fall., 5 ♂, 4 ♀.	E.A.B.	In one cell.
	Alebra albostriella, Fall., 3 ♂, 4 ♀.	E.A.B.	
	Eupteryx concinna, Germ., 2 ♀.	E.A.B.	In one cell.
	Typhlocyba quercus, F., 1 ♂, 1 ♀.	E.A.B.	
	Alebra albostriella, Fall., 1 ♂, 1 ♀.	E.A.B.	
	Typhlocyba douglasi, Edw. ?, 5 ♂, 1 ♀.	E.A.B.	In one cell.
	T. gratiosa, Boh., ♀.	E.A.B.	
	T. quercus, F., 2 ♀.	E.A.B.	
	Alebra albostriella, Fall., 1 ♂, 6 ♀.	E.A.B.	
	Eupteryx concinna, Germ., ♀.	E.A.B.	In one cell. 1 P.
	E. pulchellus, Fall., ♀.	E.A.B.	
	Alebra albostriella, Fall., 1 ♂, 7 ♀.	E.A.B.	
	Eupteryx concinna, Germ., ♀.	E.A.B.	In one cell. 1 P.
	Typhlocyba quercus, F., 1 ♂, 1 ♀.	E.A.B.	
The same. 9 Aug., '09.	*Alebra albostriella*, Fall., ♀.	E.A.B.	P.
	Typhlocyba douglasi, Edw. ?, ♀.	E.A.B.	
The same, 12 Aug., '09.	*T. douglasi*, Edw., ?, ♂.	E.A.B.	
Southfield Rd., Oxford. 15 July, '12.	*Typhlocyba quercus*, F., ♀.	O.W.R.	
	T. quercus, F., 6 ♂, 5 ♀.	O.W.R.	In one cell. 4 P.
	T. sp., ♀.	O.W.R.	
	T. quercus, F., 8 ♂, 10 ♀.	O.W.R.	In one cell. 13 P.
	T. quercus, F., 7 ♂, 11 ♀.	O.W.R.	In one cell. 11 P.
	T. quercus, F., 4 ♂, 12 ♀, 1 doubtful.	O.W.R.	In one cell. 13 P.
	Alebra albostriella, Fall., ♂.	O.W.R.	
	Typhlocyba quercus, F., 5 ♂, 5 ♀, 2 ?.	O.W.R.	In one cell. 10 P.
	T. sp., ♀.	O.W.R.	
	Alebra albostriella, Fall., 4 ♂, 1 ♀.	O.W.R.	
	Typhlocyba quercus, F., 3 ♂, 5 ♀. 1 ?	O.W.R.	In one cell. 8 P.
	T. sp., 1 ♂, 1 ♀.	O.W.R.	
	T. quercus, F., 7 ♂, 11 ♀.	O.W.R.	In one cell. 14 P.
	T. quercus, F., 5 ♂, 13 ♀.	O.W.R.	In one cell. 14 P.
	T. quercus, F., 7 ♂, 9 ♀, 1 ?.	O.W.R.	In one cell. 14 P.
	T. sp., ♀.	O.W.R.	
	T. quercus, F., 10 ♂, 8 ♀, 3 ?.	O.W.R.	In one cell. 14 P.
	Typhlocybid nymph.	O.W.R.	
	T. quercus, F., 2 ♂, 14 ♀.	O.W.R.	In one cell. 14 P.
	T. sp., ♀.	O.W.R.	
	T. quercus, F., 3 ♂, 7 ♀, 1 ?.	O.W.R.	In one cell. 8 P.

Locality and Date.	Species and Sex of Prey.	Identifier.	Notes, and Observer when not A.H.H.
The same. 27 July, '12.	*Typhlocyba* sp., ♀.	O.W.R.	
	T. quercus, F., 2 ♀.	O.W.R.	
	T. quercus, F., 5 ♂, 4 ♀, 1 ?	O.W.R.	One cell.
	T. quercus, F., 7 ♂, 10 ♀.	O.W.R.	One cell. 1 P.
	T. sp., 2 ♀.	O.W.R.	
	T. quercus, F., at least 9.	O.W.R.	One cell.
	T. quercus, F., 3 ♂, 10 ♀, 1 ?.	O.W.R.	One cell. 3 P.
	T. quercus, F., 7 ♂, 10 ♀, 1 ?.	O.W.R.	One cell.
	T. quercus, F., 3 ♂, 12 ♀.	O.W.R.	One cell. 1 emerged P.
	T. quercus, F., 2 ♂, 5 ♀.	O.W.R.	One cell. 1 P.
	T. sp., 1 ♂, 1 ♀.	O.W.R.	
	T. quercus, F., 6 ♂, 9 ♀.	O.W.R.	One cell. 1 P.
	T. quercus, F., 6 ♂, 16 ♀.	O.W.R.	One cell. 1 P.
	T. quercus, F., 7 ♂, 12 ♀.	O.W.R.	One cell. 5 P.
	T. sp., ♀.	O.W.R.	The wasp carrying this owned the next 3 cells.
	T. sp., 1 ♂, 10 ♀.	O.W.R.	Cell 1.
	T. sp., 2 ♂, 15 ♀.	O.W.R.	Cell 2.
	T. sp., 1 ♂, 18 ♀.	O.W.R.	Cell 3.
	Psylla sp., ♀.	O.W.R.	
Newtown Waters, Newbury, Berks. 12 Aug., '19.	*Typhlocyba debilis*, Dougl., ♀.	O.W.R.	
Chobham, Surrey. 22 June, '22.	*T. tenerrima*, H-S., ♀.	O.W.R.	E. B. Nevinson.

Crossocerus palmarius, Schreb.

Diptera.

Locality and Date.	Species and Sex of Prey.	Identifier.	Notes, and Observer when not A.H.H.
Lye Hill, Oxford. 5 Aug., '09.	*Coenosia tricolor*, Zett., 2 ♀.	J.E.C.	
	Chrysotus cilipes, Mg., ♀	J.R.M.	
	Scaptomyza graminum, Fln., ♂.	J.R.M.	
The same. 6 Aug., '09.	*Chrysotus cilipes*, Mg., ♀.	J.R.M.	
	Medeterus truncorum, Mg., 2 ♀.	J.E.C.	
	Oscinis frit, L., ♀.	J.R.M.	
	Scaptomyza graminum, Fln., ♀.	J.R.M.	

Crossocerus anxius, Wesm.

Diptera.

Locality and Date.	Species and Sex of Prey.	Identifier.	Notes, and Observer when not A.H.H.
Queen's Bower, New Forest, Hants. 9 Aug., '09.	*Tachydromia claranda*, Coll., 3 ♀.	J.E.C.	
West Heath, Hampstead, Middx. 25 June, '25.	*T. claranda*, Coll., ♀.	J.E.C.	O.W.R.

Crossocerus wesmaeli, V. de Lind.

Diptera.

Locality and Date.	Species and Sex of Prey.	Identifier.	Notes, and Observer when not A.H.H.
Beaulieu Rd., New Forest, Hants. 8 Aug., '09.	*Camptocladius* sp., ♀.	F.W.E.	
Beaulieu Rd., New Forest, Hants. 11 Aug., '14.	*Empis vitripennis*, Mg., ♀.	O.W.R.	
Esher Common, Surrey. 18 Aug., '22.	*Forcipomyia nigra*, Winn., ? ♂.	F.W.E.	
	Orthocladius sp., ♀.	F.W.E.	The wasp carrying this stored the following 13 insects.
	Empis vitripennis, Mg., 1 ♀, 5 ♂.	O.W.R.	
	Leucopis sp., ♀.	J.E.C.	
	Orthocladius sp., 5 ♀.	F.W.E.	
	Oscinis frit, L., ♂.	J.E.C.	
The same. 19 Aug., '22.	*O. frit*, L., ♂.	J.E.C.	
	Trichotanypus culiciformis, L., ♀.	F.W.E.	
Oxshott, Surrey, 14 Aug., '20.	*Empis vitripennis*, Mg., ♀.	O.W.R.	
The same. 14 Sept., '24.	*Rhamphomyia erythrophthalma*, Mg., ♂, ♀.	J.E.C.	O.W.R.

Crossocerus palmipes, L.

Diptera.

Locality and Date.	Species and Sex of Prey.	Identifier.	Notes, and Observer when not A.H.H.
Queen's Bower, New Forest, Hants. 12 Aug., '09.	*Tachydromia longicornis*, Mg., ♀.	J.E.C.	

Locality and Date.	Species and Sex of Prey.	Identifier.	Notes, and Observer when not A.H.H.
Liverpool district. No date.	*Agromyza pusilla*, Mg., ♀. *Psila nigricornis*, Mg., ♀. *Tachydromia longicornis*, Mg., 6 ♀, 2 ♂. *T. notata*, Mg., ♀. *T. strigifrons*, Zett., 1 ♀, 2 ♂.	J.E.C. J.E.C. J.E.C. J.E.C. J.E.C.	G. Arnold.
The University Museum Grounds, Oxford. 27 Aug., '06.	*Oscinis pusilla*, Mg., ♀. *Phytomyza flava*, Fall., ♀. *Tachydromia longicornis*, Mg., ♀.	J.E.C. J.E.C. J.E.C.	
The same. 30 Aug., '06.	*Liriomyza flaveola*, Fall., 1 ♂, 1 ♀.	J E.C.	
The same. 1 July, '08 and 3 July, '08.	*Chrysotus gramineus*, Fall., 2 ♀.	J.E.C.	
The same. 5 July, '09.	*Phytomyza flava*, Fall., ♂. *Tachydromia extricatus*, Coll., ♀. *T. calceata*, Mg., ♀.	J R.M. J E C. J E.C.	
The same. 9 July, '09.	*T. extricatus*, Coll., 1 ♂, 1 ♀.	J.E.C.	
The same. 12 July, '09 and 13 July, '09.	*Phytomyza flava*, Fall., 2 ♀.	J.E.C.	
The same. 14 July, '09.	*Empis aestiva*, Lw., ♀.	J.R.M.	
The same. 20 July, '09.	*Tachydromia annulipes*, Mg., ♀.	J.E.C.	
The same. 22 July, '09.	*T. pallidiventris*, Mg., ♀.	J.E.C.	
The same. 11 July, '10 and 13 July, '10.	*Phytomyza albipes*, Mg. [*flava* var ?], 2 ♀.	J.E.C.	
The same. 12 July, '10.	*Tachydromia pallidiventris*, Mg , ♀.	J.E C.	
The same. 13 June, '12.	*Phytomyza flava*, Fall , ♀	O.W.R.	
The same. 15 June, '12.	*Tachydromia cothurnata*, Mcq., ♂.	J.E.C.	
The same. 18 June, '12; 19 June, '12; 21 June, '21; 22 June, '22.	*Phytomyza flava*, Fall , 4 ♀.	J.E.C.	
The same. 14 July, '13.	*Phytomyza* sp , 1 ♂, 1 ♀	J.E C.	
The University Museum grounds, Oxford. 14 July, '13.	*Empis albinervis*, Mg , ♀.	O.W.R.	
University Parks, Oxford. June, '14.	*Chalarus spurius*, Fall , ♂. *Medeterus truncorum*, Mg , ♂. *Tachydromia calceata*, Mg , ♀.	O W.R. O.W R. J.E C.	
The same. 25 June, '14.	*Platycnema pulicaria*, Fall , ♂. *Tachydromia pallidiventris*, Mg , ♂.	J.E.C. J E C.	
The same. 26 June, '14.	*T. pallidiventris*, Mg., ♂.	J.E.C.	
Washford, near Kirtlington, Oxon. 16 June, '25.	*T. calceata*, Mg., ♀. *T. pallidiventris*, Mg., ♀.	J.E C J.E C	Prey of one wasp. O.W R.

Crossocerus elongatulus, V. de Lind.

Diptera.

Headington, Oxon. 27 June, '14.	*Oscinis frit*, L., ♂. *Phytomyza rufipes*, Mg. (*ruficornis*, Zett.), ♀.	J E.C. J.E.C.	F. W. Britten.
Old Town, St. Mary's, Isles of Scilly. 20 July, '25.	*Scaptomyza graminum*, Fall., ♀.	J.E C.	O W.R.

Hoplocrabro quadrimaculatus, F.

Diptera.

Minstead, New Forest, Hants. 5 Aug., '09.	*Hammomyia grisea*, Fall., ♀.	J.E.C.	
Queen's Bower, New Forest, Hants. 9 Aug., '09.	*Hilara litorea*, Fall., ♀. *Leptis lineola*, F., ♂. *Rhyphus punctatus*, F., 3 ♀. *Sapromyza pallidiventris*, Fln., 3 ♂, 3 ♀.	J.E.C. J.R.M. J.R.M. J.R.M.	
The same. 10 Aug., '09.	*Rhyphus punctatus*, F., ♂. *Sapromyza pallidiventris*, Fall., ♀. *Tanypus nebulosus*, Mg., ♂.	J.R.M. J.R.M. F.W.E.	

Locality and Date.	Species and Sex of Prey.	Identifier.	Notes, and Observer when not A.H.H.
The same. 12 Aug., '09.	*Heteromyza commixta*, Coll., ♀. *Hilara flavipes*, Mg., ♀. *H. litorea*, Fall., ♀. *Rhyphus punctatus*, F., 4 ♀. *Sapromyza pallidiventris*, 3 ♀, 3 ♂. *Leptis lineola*, F., ♂. *Sapromyza pallidiventris*, Fall., ♀. *S. pallidiventris*, Fall., 1 ♂, 2 ?.	J.E.C. J.E.C. J.E.C. J.R.M. J.R.M. J.R.M. J.R.M. J.R.M.	 Prey of one wasp. In one burrow.
The same. 16 Aug., '10.	*Empis vitripennis*, Mg., 2 ♀. *Sapromyza pallidiventris*, Fall., ♂.	O.W.R. O.W.R.	
	Lepidoptera.		
The same. 9 Aug., '09 and 12 Aug., '09.	*Epiblema corticana*, Hb., 2 ♂.	E.G.R.W.	
	Trichoptera.		
The same. 12 Aug., '09.	*Nannophryganea minor*, Curt., ? sex.	O.W.R.	
	Acanthocrabro vagabundus, Pz.		
	Diptera.		
Tubney, Berks. 6 July, '02.	*Trimicra pilipes*, F., ♂.	F.W.E.	
Wicken Fen, Cambs. June, '15.	*Nephrotoma quadrifaria*, Mg., ♀. *Tipula lunata*, L. (*ochracea*, Br. Cat.), ♂. *Pachyrrhina flavescens*, L. (*maculosa*, Br. Cat.), ♀.	F.W.E. F.W.E. F.W.E.	E. B. Nevinson. . . . .
	Cuphopterus signatus, Pz.		
	Diptera.		
Queen's Bower, New Forest, Hants. 9 Aug., '08.	*Leptis tringaria*, L., ♂.	C.J.W.	
	Cuphopterus serripes, Pz.		
	Diptera.		
Cardross, Dumbartonshire. 19 July, '07.	*Pollenia rudis*, F., ♀.	O.W.R.	? captor.
Dawlish, S. Devon. 30 July, '06.	*Scatophaga*, probably *litorea*, Fln., ♀.	J.W.Y.	A. E. Holdaway.
	Ablepharipus podagricus, V. de Lind.		
	Diptera.		
Shotover, Oxford. 22 July, '06.	*Psectrosciara soluta*, Lw., 2 ♀.	F.W.E.	
The same. 9 Aug., '07.	*Scatopse albitarsis*, Zett., ♀. *Swammerdamella brevicornis*, Mg., ♀. *Scatopsid* sp.	F.W.E. F.W.E. O.W.R.	
The same. 28 June, '08.	*Swammerdamella brevicornis*, Mg., ♀.	F.W.E.	
The same. 7 Aug., '09.	*Psectrosciara soluta*, Lw., 3 ♂, 1 ♀. *Swammerdamella brevicornis*, Mg., 2 ♂.	F.W.E. F.W.E.	
The same. 10 Aug., '09.	*S. brevicornis*, Mg., ♀.	F.W.E.	
The same. 12 Aug., '09.	*Dasyhelia* sp., ♂.	F.W.E.	
The same. 24 Aug., '10.	*Swammerdamella brevicornis*, Mg., ♀.	F.W.E.	
The same. 21 July, '12.	*Schizohelia leucopeza*, Mg., ♀. *Sciara* sp., 2 ♀.	F.W.E. F.W.E.	
Bayswater, Oxon. 16 June, '15.	*Forcipomyia ? nigra*, Winn., ♀. *Oscinis frit*, L., ♂.	F.W.E. J.E.C.	
	Physosceles clavipes, L.		
	Psocidae.		
Wellington College, Berks. 11 Aug., '06.	*Peripsocus subpupillatus*, McL., 4 ? sex, and 149 nymphs.	E.S.	
	Lindenius albilabris, F.		
	Rhynchota.		
	Y = Young.		
Hogley Bog, Oxford. 8 July, '06.	*Adelphocoris norvegicus*, Gmel., 1 ♂, 1 Y. *Plagiognathus chrysanthemi*, Wolff, 2 ♂, 1 ♀, 1 Y. *Adelphocoris norvegicus*, Gmel., 1 ♀, 2 ♂, 9 Y. *Megalocerаea ruficornis*, Fall., 1 ♂, 1 ♀. *Plagiognathus chrysanthemi*, Wolff, 2 ♀.	E.S. E.S. E.S. E.S. E.S.	 Specimens lying outside the burrows.

Locality and Date.	Species and Sex of Prey.	Identifier.	Notes, and Observer when not A.H.H.
The same. 14 July, '06.	*Adelphocoris norvegicus*, Gmel., 2 Y. *A. norvegicus*, Gmel., 3 Y. *Macrocoleus molliculus*, Fall., ♂. *Plagiognathus chrysanthemi*, Wolff, 3 ♀, 1 ♂, 1 Y.	E.S. E.S. E.S. E.S.	Specimens lying outside the burrows.
The same. 20 July, '06.	*Adelphocoris norvegicus*, Gmel., 2 Y.	E.S.	
The same. 7 Aug. '07.	*Adelphocoris norvegicus*, Gmel., Y. *Plagiognathus chrysanthemi*, Wolff, 1 ♂, 1 ♀.	O.W.R. E.A.B.	
The same. 20 July, '07.	*P. chrysanthemi*, Wolff, ♀.	E A.B.	
Shotover, Oxford. 17 Aug., '14.	*Notostira erratica*, L., Y. *Plagiognathus chrysanthemi*, Wolff, 7 ♀.	O.W.R. O.W.R.	
Tubney, Berks. 8 Aug., '06.	*P. chrysanthemi*, Wolff, ♀.	E.S.	
The same. 21 July, '07.	*Adelphocoris* sp., 2 Y. *A. roseomaculatus*, Deg., Y. *Amblytylus affinis*, Fieb., 1 ♂, 2 ♀. *Conostethus roseus*, Fall., 2 ♀. *Plagiognathus chrysanthemi*, Wolff, 5 ♀, 5 ♂. *Poeciloscytus unifasciatus*, F., ♀. *Amblytylus? affinis*, Fieb., ? ♀. *Plagiognathus chrysanthemi*, Wolff, 6 ♀, 1 ♂.	O.W.R. E.A.B. E.A.B. E.A.B. E.A.B. E.A.B. E.A.B. E.A.B.	Specimens left outside the burrows.
The same. 5 Aug, '13	*P. chrysanthemi*, Wolff, ♀.	O.W.R.	
Wellington College, Berks. 11 Aug., '07.	*Orthotylus ericetorum*, Fall., ♂.	E.A.B.	
Queen's Bower, New Forest, Hants. 4 Aug., '07.	Capsid larva.	O.W.R.	
The same. 9 Aug., '09.	*Stenotus binotatus*, F., ♂.	O.W.R.	
The same. 10 Aug., '09.	*Notostira erratica*, L., 3 Y. *Trigonotylus ruficornis*, Fourc., ♀.	E.A.B. E.A.B.	
Oxshott, Surrey, 14 Aug., '20.	*Miris* sp., Y. *Notostira erratica*, L., ?, Y. *Plagiognathus chrysanthemi*, Wolff, 2 ♀, 1 ♂, 1 Y. Capsid nymph., 2 Y.	O W.R. O.W.R. O.W.R. O.W.R.	
	Diptera.		
Lye Hill, Oxford. 14 July, '06.	*Meromyza laeta*, Mg., ♀.	J.W.Y.	Specimen left by the wasp outside the burrow
Hogley Bog, Oxford. 6 Aug., '09.	*M. pratorum*, Mg., ♀.	J.R.M.	

Lindenius panzeri, V. de Lind.

	Diptera.		
Beaulieu Rd., New Forest, Hants. 8 Aug., '09.	*Chlorops troglodytes*, Ztt. (*humilis*, Lw.), ♂.	J E C.	
Denny Bog, New Forest, Hants. 18 Aug., '10.	*Ch. rufina*, Zett., ♂. *Ch. taeniopus*, Mg., 6 ♂.	J E.C. J.E.C.	
Oxshott, Surrey. 13 Aug., '20.	*Meromyza laeta*, Mg., 3 ♂. *Chlorops taeniopus*, Mg., 74 ♂, 2 ♀.	J.E.C. J.E.C.	Only some of these seen by J.E.C.

Entomognathus brevis, V. de Lind.

	Coleoptera.		
Queen's Bower, New Forest, Hants. 1 Aug., '07.	*Cryptocephalus labiatus*, L., at least 14.	O.W.R.	From a burrow.
Tubney, Berks. 1 Sept., '10.	*Longitarsus jacobaeae*, Wat., ♀.	O.W.R	

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THE LIFE-HISTORIES OF CERTAIN AFRICAN NYMPHALID BUTTERFLIES OF THE GENERA *CHARAXES*, *PALLA*, AND *EUXANTHE*.

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[Read June 2nd, 1926.]

PLATES LXXIV–LXXX.

CONTENTS.

INTRODUCTION.

THE wonderful transformation exhibited in the metamorphosis of Lepidoptera has ever been a fascinating study to the writers, and in the following notes we have attempted to record our observations on the early stages of those species of Nymphalid butterflies, included in the subfamily CHARAXIDINAE, which have come under our notice.

The genera dealt with are particularly interesting, not only in regard to the wonderful virility and coloration of the imagines, but also in their early stages.

The larvae are characteristic; with the exception of the head and the anal extremity, the segments of the body are unarmed. In some species the body is smooth, but the majority have the upper surface finely granular or papillated.

The head is usually large, carrying on its upper margin two or more spinous "horns" which vary in shape, size and position, thus forming useful guides to the differentiation of groups or even species. The anal "horns" or tails are at first long, but gradually become shortened with each successive moult.

In the genus *Charaxes*, the larvae are of various shades of green after the first or second moult, thickest at about the fifth and sixth segments and tapering fore and aft. Many species are uniform in colour on the dorsum, while others are ornamented with spots, of varying shape and colour, invariably situated on one or more of the sixth, eighth, and tenth segments; also in some species the sides are decorated with oblique black or yellowish lines.

The larvae are as a rule very sluggish, becoming more active at sunset. They feed mostly at night, and return to a particular leaf to rest during the day. This "base" is usually sheltered from the sun. The surface of the leaf, or of several leaves if they are small, is spun over with fine silk to an extent sufficient to accommodate the larva; but if the base becomes too small for the growing insect it will migrate to a larger leaf and spin this over. It frequently happens that the presence of these discarded "bases" is the first indication that a tree or bush harbours *Charaxes* larvae.

The mature larva ceases to feed about twenty-four hours before it commences to search for a spot at which to pupate. Having selected a suitable site, it covers a small area with silk threads and, attaching itself to this spot by its hind claspers, hangs head downwards, with the body curved ventrally. In most species there is a change in colour during the twelve hours prior to casting the skin. The skin is shed in the usual way, the pupa being attached by hooklets on the cremaster. The form of the cremaster varies in each species and is useful for differentiation of pupae.

The pupae of all the *Charaxes* conform to a common pattern, showing slight modifications in each species. They are thick and squat, pointed at the head end, smooth and ventricose over the dorsum of the thorax and abdomen. The pupae are generally green in colour with faint shading of bluish or greyish, more especially over the wing-coverings. The notable exceptions to this general coloration are found in the *Ch. etesipe* group.

The eggs are almost spherical, with a slightly flattened top which is ornamented with radiating lines. They are usually white or cream in colour.

The strong development of "horns" on the heads of the larvae in the genera *Charaxes*, *Palla* and *Euxanthe*, coupled with a somewhat similar body-structure in the three genera, serves to confirm the very close affinity which has been inferred from other characters.

We would take this opportunity of recording our keen appreciation of the help accorded to us by Prof. Poulton in revising this paper; and acknowledging our thanks to the Keeper of the Kew Herbarium, Mr. A. D. Cotton, and his assistants, Dr. J. M. Dalziel and Mr. J. Hutchinson, also to Dr. A. B. Rendle, F.R.S., Keeper of the Botanical Department of the British Museum (Nat. Hist.), for identifying the various "food-plants" and so adding to the utility of these notes, particularly for field-workers.

The species of *Charaxes* are arranged in the order of the classification recently prepared by Dr. Karl Jordan and published in Prof. Poulton's paper in *Proc. III Internat. Entom.-Kongr.*, vol. ii, p. 569, 1926.

1. **Charaxes varanes vologeses,** Mab.

EGG. Pl. LXXIV, fig. 1.—*Ch. varanes* lays its eggs on three species of *Allophyllus* (SAPINDACEAE)—*macrobotrys* Gilg., a species near *subcoriaceus* Bak. f. , and an undetermined food-plant ("Nkuzanyana" in Luganda). Of these small trees, which are commonly found in the forests round Nairobi, the first two are also the food-plants of *Ch. f. fulvescens* and the last that of

fulvescens ? acuminatus. At the coast *varanes* oviposits on a creeper which abounds on the coral cliffs of Mombasa Island.

The eggs are white or yellowish when first deposited, but turn quite brown just before the larva emerges. The top is flat and slightly fluted. There is no apparent difference between the egg of this species and that of *fulvescens*.

YOUNG LARVA.—The newly-emerged larva is dirty yellowish in colour and has a pair of long whitish tails and a black head with short white-tipped horns. These horns are mere tubercles when the larva has just emerged, but they are gradually extruded within the first twelve hours. The first meal is made off the egg-shell, and green food is not touched until the evening of the day on which the larva hatches.

The head in the first two instars is blackish or brownish, but in the third instar when the body becomes green, the head also takes on this colour. The body-spots appear at this stage.

MATURE LARVA. Pl. LXXVI, fig. 6; Pl. LXXIX, fig. 4.—The mature larva is dull olive-green or grey-green, heavily papillated with white-tipped tubercles, so that the whole surface has a finely speckled appearance. The dorsal spots are present on the sixth, eighth and tenth segments. In shape they are like those of *fulvescens*, and in colour they may be either greyish or brick-red. Sometimes only two spots are present.

HEAD. Pl. LXXVIII, figs. 2, 6, 14–17; Pl. LXXIX, fig. 4*a*.—The larval head is characteristic, and it is noteworthy that the Nairobi and Coast form of *varanes* is in this respect quite distinct from the Uganda race. The chief points of difference are—(1) the horns of the eastern form are more slender and uniformly green in colour; (2) the lateral pair, seen from the front, form a nearly straight line with the lower half of the face, the corresponding contour being distinctly concave in the north-western form; (3) the central pair are first directed up, back, outwards and then inwards, while those of the Uganda insect project up, forwards, outwards and then slightly forwards at the tips. Further the tips and bases of the north-western form are blackish. There is therefore a marked difference between the head of the Nairobi *varanes* and that of *fulvescens* in Uganda, whereas, as we have stated on p. 336, we cannot separate the larvae of the two species as they occur in Uganda. (Cf. Pl. LXXVIII, figs. 2, 5, 6, 14–17.)

2. **Charaxes fulvescens monitor**, Rothsch.

EGG.—The egg of this species is 1·5 mm. in diameter, of the usual *Charaxes* form, pearly-white in colour, and laid usually singly on the young shoots of the two food-plants already named under *Ch. varanes*. *Allophyllus macrobotrys* is usually selected by the female for oviposition.

Signs of development are first seen at the rim of the depression and the mature egg gradually turns blackish-brown.

YOUNG LARVA.—When the larva is newly emerged it is of the usual olive colour with a black head, and there is nothing specially noteworthy about its earlier development.

ADULT LARVA. Pl. LXXVI, fig. 5; Pl. LXXX, fig. 5.—When fully grown the larva is about 6–6·5 cm. in length; the body is a dull sage-green colour, heavily papillated over with glistening white spines, simple in nature. There is no distinct body-line. Many specimens have three, others two, crescentic spots or rather blunt trident-shaped figures with the prongs pointing forward on the dorsum of the sixth, eighth and tenth, or the sixth and eighth segments,

respectively.* In some larvae these marks are very distinct, in others evanescent.

HEAD. Pl. LXXVIII, fig. 5.—This head is most characteristic and resembles in front view a somewhat quadrilateral convex plate, dark-green, finely papillated, and surmounted at its upper corners by two very long (7 mm.) horns which run outwards, upwards and at the tips are incurved towards the mid-line. Each is cylindrical and heavily spined, and its extreme tip is white with a black band immediately below. There are two others (4 mm. long) which arise from the sides and curve upwards and outwards; they are heavily spined and also sharp-pointed. There is no face-line.

PUPA. Pl. LXXX, fig. 5*a*.—The pupa is pale-green and the spiracles, like those of *pollux*, are marked by reddish spots. The head-covering in the pupa is markedly bifid. The imago emerges in fourteen days. The wing-cases and thorax are decorated with diffuse whitish streaks.

These striking-looking larvae are easily reared, as they feed voraciously, chiefly at night. So far we have not been able to detect any difference between these larvae and those of *varanes*. The pupae are also alike.

3. **Charaxes fulvescens**, s.-sp. ? **acuminatus,** Thurau.

Examples of *fulvescens* from the Kikuyu Escarpment differ from the race *monitor* in their much brighter and richer colouring. The costa of the fore-wing is more curved, especially along the terminal third, and the outer margin is more deeply incised, thus forming an acutely angled apex, in this respect agreeing with *acuminatus*. The apical and marginal areas are much deeper brown—almost blackish—so that the submarginal and cellular orange spots are conspicuous. In the hind-wing the submarginal and cellular spots are darker and more distinct. The basal whitish areas of both fore- and hind-wings are distally bordered by a somewhat defined orange-yellow band which contrasts with the dark margin and apex. Allowing for individual variation, the under surface is richer and darker than in the other forms.

The series of specimens we have studied was taken at a height of 7500-8000 ft., near Uplands Station on the Uganda Railway. A similar form captured by Canon K. St. Aubyn Rogers on Kilimanjaro (May 1905), and another by Dr. G. D. H. Carpenter on a hill (about 7500 ft.) near Kigezi, S.W. Uganda (20 February, 1916), exist in the Hope Dept., Oxf. Univ. Museum.

These Kikuyu, Kilimanjaro and Kigezi examples are apparently restricted to high elevations, with a comparatively low temperature, contrasting in this respect with the Congo, Uganda, and East Coast races of *fulvescens* which inhabit hotter, more tropical, lower countries.

At Uplands the eggs were laid upon the third food-plant of *Ch. varanes*—an undetermined species. The appearance of the larva and larval head is represented on Pl. LXXVII, fig. 3, and Pl. LXXVIII, figs. 9, 10.

4. **Charaxes candiope candiope,** Godt.

EGG. Pl. LXXIV, fig. 5.—This species lays its eggs on the upper or under surface of the leaves of the "Brown Olive," *Croton megalocarpus* Hutch. = *Elliotianus* Pax et Engl. (EUPHORBIACEAE), a common-tree of the highland forests in Kenya, and known to the Kikuyu as "Makinduli." We do not

* In fig. 5 of Pl. LXXX the dorsal spots should be on segments 6, 8 and 10, and not as depicted.

know the food-plant in Uganda, for this particular *Croton* does not exist in that country.

The eggs are deposited with great rapidity, not all on one leaf or even one tree, but the time between the actual settling and the deposition cannot be more than a second; and off the insect goes to another tree. When first deposited the eggs are bright canary-yellow, but they soon turn dull yellow and in a day become bright brick-red. This colour is highly cryptic, agreeing absolutely in tint with the numerous spots of fungus-burn to which the leaves of the *Croton* are especially liable. Just before the larva emerges, the egg turns black. The egg stage lasts eight to ten days.

YOUNG LARVA. Pl. LXXVI, fig. 4.—The young larva is at first dull olive-yellow, with black head, numerous very fine papillae over the body, and a pronounced bifid tail. At first moult it becomes greener and the tail is reduced in length, but the horns on the head are well developed.

At the second moult the dorsal spots make their appearance on the sixth and eighth segments. At this stage the number of spots is not constant, but the usual number is three to each segment.

The head is green, with white papillae and surmounted by greyish-brown, strongly divergent horns.

MATURE LARVA. Pl. LXXVI, fig. 1.—In the last stage the larva is leaf-green, with the under surface grey-green, the whole finely papillated. A yellowish line runs the length of the body from the second segment to the tail, separating the greyish under surface from the green above. This line subsequently becomes pink, and each segment bears a row of pink or yellow spots along its anterior edge. The tails are ochreous in colour.

HEAD. Pl. LXXVIII, fig. 21.—The head is very characteristic, being rather oval in outline but slightly more pointed towards the mouth. The lower horns arise at about two-thirds up the side and are set well out and then curve slightly upwards. They are, as usual, separated from those of the inner pair by small spinous processes. The inner horns are almost straight and very divergent—more so than in any other *Charaxes* larva we have reared. Two short spines arise, one on either side of the mid-line. The head is green, with the horns and entire margin yellow-ochreous tinged with grey. The dorsal spots, situated on the sixth and eighth segments, are also characteristic of the species. Each segment bears three spots set transversely, two small ones laterally and a large central one; that on the sixth is larger and is composed of three contiguous parts, a long oval anteriorly, then a narrower though equally long section, at the rear of which follows a short oval. The central spot of the eighth segment is made up of two long, narrow, contiguous ovals with smaller ovals fore and aft. The lateral spots are almost round. All are ochreous in the centre, and white outwardly. The tails on the last segment are fairly long and ochreous in colour.

The larval stage lasts about twenty days.

PUPA.—The pupa is very like that of *cithaeron*, but is smaller with a more marked thoracic ridge, and the bluish-white shading more evident. Furthermore the cremaster is of a different shape. The insect emerges in fifteen to twenty days.

HABITS.—This is perhaps the commonest species of *Charaxes* in the Nairobi district and while the males come readily to bait and are to be seen flying and feeding, the females are only slightly less common. The butterflies are particularly pugnacious towards others of their own and of different species. They will fight with striking fierceness over some particularly attractive wound

in a tree, battering each other with their wings and sidling one another off the choicest titbits. One frequently comes upon an old male with denuded remnants of wings which have been so destroyed as to make flight well-nigh an impossibility. This species is particularly long-lived and will live in captivity for well over a month. *Candiope* frequents open scrub and forest country with equal fondness for both, so long as food is plentiful in either.

5. **Charaxes jasius epijasius,** Reiche.

Egg.—The eggs of this species are canary-yellow when first laid and measure 1·25 mm. in diameter. They are deposited on the leaves and stems of a species of *Sorghum*, known in Luganda as "Mwemba," and in Kavirondo as "Matama." They are almost spherical, the top being slightly flattened and ornamented with shallow fluting. The egg stage lasts seven to ten days.

Larva. Pl. LXXIX, fig. 5.—The young larva proceeds to devour the egg-shell as soon as it has emerged, and in the first instar it is hardly to be distinguished from the young larva of *Ch. c. castor*. Growth is very rapid, and the colour changes from yellowish-olive to bright grass-green at the second moult.

Although in many ways this larva resembles that of *castor*, it can be recognised by its more emerald-green colour and finer papillation. The dorsal spots are quite distinct, occurring on the sixth and eighth segments; they are oval in outline and of a greyish colour, bordered with black. The hind spot is not always well defined and is frequently spindle-shaped. The lateral body-line is cadmium-yellow and extends from the second segment to the tail. The larvae become full-fed between the fourteenth and eighteenth days.

Head. Pl. LXXVIII, fig. 18.—The head resembles that of *castor*, but is less robust; it carries four long, pointed, pink-tipped horns, the inner pair being separated by two short spines, while a similar spine projects between each lateral and inner horn. A yellow line, edged with black, runs from the outer side of the lateral horns to the mouth-parts.

Pupa. Pl. LXXIX, figs. 5*a*, 5*b* (anal extremity).—The pupa is somewhat like that of *Ch. pollux*, in that the lateral aspect of the abdominal segments is decorated with reddish spiracular spots. The distal edges of the wing-cases are outlined by a white streak. The head is thick-set and truncate.

Habits.—The imago emerges in ten days. This insect is very local, its distribution being doubtless governed by that of its food-plant, for it is seldom found anywhere except near the fields of *Sorghum*. Owing to this habit one can always capture both males and females in such cultivated areas.

6. **Charaxes castor castor,** Cram.

Egg.—The egg of *Ch. castor castor* is a spherical object, 2 mm. in diameter, pearly yellow in colour and slightly cupped and fluted on the top. It is laid singly on the upper surface of the leaves of the food-plants, principally a *Sorghum* with the native name of "Mwemba" in Luganda, "Matama" in Kiswahili [probably *Sorghum Roxburghii* Stapf]; also on *Gymnosporia senegalensis* Loes. (Celastraceae) and a creeper, *Tragia cordifolia* Vahl. (Euphorbiaceae).* A brown ring appears round the depression as the germ develops,

* Canon K. St. Aubyn Rogers informs us that, in the coast district of Kenya Colony, *Ch. c. castor* feeds on *Afzelia cuanzensis* Welw. (Leguminosae), in Kiswahili "Mbamba kofi,"—also the food-plant in the same area of *Ch. saturnus*, Btlr., *protoclea azota*, Hew., *etesipe tavetensis*, Rothsch., and probably of *boueti lasti*, Gr.-Sm.

and the whole egg becomes a dark-brown colour. The larva emerges in from eight to ten days and at once devours the shell.

YOUNG LARVA.—The newly emerged larva is olive-yellow in colour with a black head. It is a most voracious feeder and is easily reared. It assumes a greener tint with each moult, and the spots appear after the third.

ADULT LARVA. Pl. LXXV, fig. 2; Pl. LXXIX, fig. 2.—The adult larva is a most conspicuous object, as it is about 9 cm. long with a grass-green body covered with coarse, closely-set papillae. The tip of each papilla is light-yellowish in colour, giving to the larva a speckled appearance and also showing off the papillae as a series of vertical bands. The body-line is formed by a series of cream-coloured papillae, forming a spiracular line extending from the second segment to the tail.

Most larvae have two dorsal spots, although some only possess one. They are placed on the sixth and eighth segments, and each forms a conspicuous black oval, set nearer to the front of a smooth oval green area having its long axis parallel with that of the body. The number of these spots bears no relation to sex or to any other characteristic so far as has been observed.

HEAD. Pl. LXXVIII, fig. 4; Pl. LXXIX, fig. 2*a*.—The face has the form of a hexagonal plate with its two lower sides elongated. The plate, which bears fine dark-green papillae, is divided by a vertical central groove, expanding into a smooth green area above the mouth-parts. Two stout side horns arise as the prolongation of the angle between the two lateral sides of the hexagon, and thus are set outwards, but afterwards curve slightly inwards, especially at the tips. Each horn is 6 mm. long, very serrated and coloured deep maroon on its inner aspect. From the upper angles of the plate arise two similar finely serrated horns, with their tips a deep maroon colour and slightly curving inwards (length 5 mm.). The yellow face-line starts from the tips of the lateral horns and runs downwards along the outer aspect of the face, almost to the mouth-parts; it is bordered along the outer and lower edge by a conspicuous black line which starts from the base of the lateral horns and reaches the mouth-parts.

PUPA. Pl. LXXIX, fig. 2*b*.—The pupa is very large, of the usual *Charaxes* form, and opaque light-green in colour; on the second day certain characteristic white patches appear on the wing-scuta and also on the dorsum. Before the imago emerges these disappear and the large spots of the wing show through.

HABITS.—The whole transformation from egg to imago can be completed within six weeks, as the larva is a most voracious feeder and grows quickly. This species is very common. The males are easily trapped in the open with fowl-droppings, although the females are only met with near the food-plants, when about to oviposit.

7. **Charaxes brutus brutus,** Cram.

EGG. Pl. LXXIV, fig. 2.—The eggs of *Ch. brutus brutus* are laid singly on the upper surface of the leaf of at least two food-plants—(1) an undetermined tree with broad lanceolate leaves, "Kiujamata" in Luganda, which we also believe to be sometimes the food of *Ch. numenes*; (2) a shrub with white, wax-like berries, *Grewia* sp. (TILIACEAE), "Lukandwa" in Luganda. *Brutus* also lays on the Cape Lilac, *Melia azedarach* Linn. (MELIACEAE), and the eggs being 2 mm. in diameter and pearly white, they stand out most conspicuously against the dark-green leaves. This is an imported plant in Uganda, but Platt gives it

as the food-plant of this species in South Africa in his *Food-plants of S. African Lepidopterous Larvae.* The choice of this imported tree is therefore interesting, but the fact remains that the larvae refuse to touch the leaves and we have not found a single wild larva on the tree.

The egg is of the usual *Charaxes* form, but the cupped fluting is not marked at all; development first shows at the rim and the mature egg is very dark brown. The eggs mature in eight to twelve days.

YOUNG LARVA. Pl. LXXV, fig. 6.—The young larvae are an olive colour with black head when newly emerged, and later become green, but as they appear to be fastidious eaters, they grow slowly and have a considerable mortality.

ADULT LARVA. Pl. LXXIX, fig. 1.—The mature larva is about 55·0 mm. long; body dark emerald-green colour, with fine papillae over the dorsal and lateral surfaces. The under parts are very light green. There is no body-line, but the sides have a series of faint C-shaped marblings.

In the young larva, after the third moult, the dorsal spot, always on the sixth segment, first appears as a white dot. In the adult the spot is extremely variable, being sometimes oval and reddish-brown on a light grey ground, sharply marked off from the green of the body by a fine brown line; at other times a bright red oval on a grey-green area; or it may be represented by a grey heart-shaped area with its point directed backwards and having a crimson centre.

HEAD. Pl. LXXVIII, fig. 8; Pl. LXXIX, fig. 1*a*.—The head is somewhat oblong, square-cut at the mouth; the mouth-parts show up clearly as jet-black dots. The head has a distinct bluish tinge and is divided vertically by a central groove and is covered with fine papillae. Two somewhat thick horns (4 mm.) arise from the lateral aspect of the upper third of the face, curve upwards and slightly outwards, while two (3 mm.) project from the upperside and curve slightly backwards. All are finely papillated. Between the central horns are two spinous processes, and one between each central and lateral horn. There is a yellow line which, starting from the base of the outer horns, extends round the edge of the face, and meets over the mouth-parts.

PUPA.—The pupa is very much like that of *Ch. pollux*, pale green in colour with a row of six reddish spots representing the position of the abdominal spiracles. The keeling along the wings and on the thorax is rather more marked. The imago emerges in fourteen days.

HABITS.—*Charaxes brutus* is a very common and easily trapped species. Almost every collection of leopard-droppings on the roadside will bear one or two male specimens of this species. When the females are ovipositing they do so very rapidly, as we have noticed four eggs laid in quick succession within five minutes.

8. **Charaxes ansorgei**, Rothsch.

EGG.—The egg is smooth, spherical, with a concavity on the top. Numerous fine furrows cross from the margin of the concavity towards the centre, where they become obsolescent. When freshly laid the egg is pale yellow, changing to pinkish-brown with the upper third purplish-brown. Eggs are deposited either on the upper or lower surfaces, principally the latter, of the young or old leaves of a thorny semi-creeper, *Bersama abyssinica* Fresen. (MELIANTHACEAE).

YOUNG LARVA.—The larva emerges in about ten days, and is at first a

dingy yellowish colour, turning in forty-eight hours to apple-green. The first meal is made off the egg-shell. The head, which is blackish, bears on the top divergent inwardly curving horns in the plane of the face, and a minute pair between the inner horns. There is a pair of horns of about the same length as the head horns, on the anal segment; these are also divergent and inwardly curved. The surface of the head has a few pale-tipped tubercles. The horns are bluntly spiny with whitish tubercles, each bearing a minute pale hair on the tip. A few hairs are scattered over the body. Length on hatching, 3 mm.; before first moult, 7 mm. When ready for the first moult the new head is visible under the skin of the first segment as a circular pinky-brown patch. The colour of the larva in the second stage is very similar to that of the first, but the body is covered with numerous small hair-bearing pale tubercles and each segment shows a fine lateral oblique line of white papillae, slanting from above forwards. There is a white subspiracular line dividing the green of the dorsum from the pale under surface. A pair of white dorsal specks is present on each segment. Length before second moult, 12 mm. In the third stage the upper half of the head is maroon, and the horns are brown, the lower half yellowish-green, with a few pale tubercles. The maroon colour is frequently retained up to the time of pupating, occasionally it gradually disappears after the final moult. Rest of the body as in the second stage, but in addition there is a small roundish spot bordered by a black line on the sixth segment. This spot is more pronounced in some individuals than in others. In the position of rest, the head and first three segments, as also the terminal segments, are raised above the surface of the leaf.

Adult Larva. Pl. LXXVII, figs. 4, 5.—In the fourth and fifth stages there is little difference. The body is pea-green, thickly covered with yellow papillae. The oblique lateral lines are pronounced. The subspiracular white line is continued round the anal spines, becoming yellowish in this region. The roughly circular spot on the dorsum of the sixth segment is brownish, surrounded by a paler area and outlined in black, and very often a second spot is developed on the eighth segment. The anal processes are short, broad, pointed and flattened horizontally. Length, 53 mm. The larval stage lasts about three to four weeks.

When the larva has curled, ready for pupation, it loses most of its spots and becomes translucent.

Head. Pl. LXXVIII, figs. 11–13.—The head is pale green with a large purplish patch over the upper half of the face, while the tips of the horns are violet-blue. The lengths of the horns are relatively shorter than in the earlier stages. The whole of the head is coarsely punctate with scattered white tubercles, and with rather long silvery pubescence.

Pupa.—The pupa is stout, widest at the third abdominal segment, thence tapering abruptly to the tail; anteriorly it narrows slightly to fore end of wing-case and then more sharply to the front extremity, where it terminates in a slightly indented emarginate ridge. Ventral surface of thorax straight, dorsal much curved. A lateral ridge on each side of the thorax, starting from the head projections, and extending along the wing-cases, ends at the front of the abdomen, where it becomes obsolete. The base of the cremaster is transversely bilobed, and two excrescences are placed anteriorly to it on the ventral surface. The colour is a light green with pale chalky-pink marks on the points of the head-cover, also irregularly placed along the lateral ridges and scattered on the under surface of the thorax. The spiracles appear as dark spots on a chalky-pink ground. On either side of the proboscis is a

conspicuous round white spot. The cremaster and adjacent excrescences are yellowish. Length 25 mm.; breadth 11 mm. The complete metamorphoses extended over ten weeks. The imago emerged in sixteen days.

HABITS.—*Ch. ansorgei* is a rare insect, with a very restricted range, being apparently confined to the high Kikuyu Escarpment, Mau Plateau and Nandi Range. The female is an evident mimic of *Ch. brutus*.

9. **Charaxes pollux pollux**, Cram.

EGG.—The eggs are laid singly on the upper surface of the young leaves of two food-plants—a species of *Sorindeia* (ANACARDIACEAE), with the name "Muziru" in Luganda; also on *Bersama abyssinica*, the food-plant of *Ch. ansorgei*. The eggs are at times deposited one or even two on another.

They are of the usual *Charaxes* form, a sphere with a saucer-shaped, fluted depression on the top, pearly-white in colour and 1 mm. in diameter. At an early stage of development three radiating lines appear on the surface, giving the egg a marbled appearance: when mature it is greyish-black.

YOUNG LARVA. Pl. LXXV, fig. 3.—The young larva hatches in from seven to ten days and at once eats the egg-shell and feeds on the young leaves, descending as it grows, to the lower, more mature leaves. The larva is at first of a uniform pale olive colour, with a black head: the tint then changes with each successive moult to a translucent green which is smooth and immaculate until after the third moult, when one or two dorsal spots appear on the sixth and eighth segments respectively.

ADULT LARVA. Pl. LXXX, fig. 3.—The adult larva, about 6 cm. in length, has a bright-green, smooth-skinned body with one or sometimes two circular, rusty-red spots on a white ground, enclosed by a fine brownish line. In some larvae the rusty-red tint changes later on to a bright blood-red. When only one spot appears it is invariably on the sixth segment, the second if present being on the eighth. When at rest the larva lies along the midrib of the leaf, with its head raised. As a rule one finds only a single larva to each leaf.

HEAD. Pl. LXXVIII, fig. 7; Pl. LXXX, fig. 3*a*.—The head is characteristic of the species, being in front view somewhat quadrate in outline and having two pairs of very spiny horns—a central, straight pair arising on either side of the mid-line, the lateral pair arising from just below the upper angles and curving slightly backwards and inwards. There are two short sharp-pointed spines between the central pair and one on either side of the lateral horns. The general colour of the head is a uniform bluish-green. No face-line is present, but the lateral tubercles and spines on the horns are strongly developed.

The larval stage lasts eighteen days.

PUPA.—The colour of the pupa is light-green on the thorax and wing-cases, becoming bluish-white as it approaches the dorsum of the abdominal segments. Three white patches are present on each wing-case, while the abdominal spiracles are represented on either side by a row of six reddish-brown spots. The head is somewhat bifid.

The pupal period extends to ten days.

HABITS.—*Charaxes pollux* would appear to have a preference for the more open park-like country rather than the forest. Although a common species it is more frequently captured when feeding on droppings, or when sucking the exudate from a wounded tree. This exudate when fermented renders the insect easy to capture by hand. As with most *Charaxes*, males are far more in evidence than females, these latter being more retiring in their habits.

This species would appear to have no definite or limited breeding-season, as fresh eggs and larvae in all stages of growth are found throughout the year.

10. **Charaxes druceanus proximans**, Joic. & Talb.

EGG.—The eggs are laid on the under surface of the leaves of *Eugenia* sp. (MYRTACEAE), a creeping shrub. They are spherical and glossy, with a shallow concavity on the top. Fine radial ridges pass from the edge of the depression, converging towards the centre, where they become obsolescent. When first laid the egg is yellow, but in twenty-four hours the upper part becomes streaked with pinkish lines. Still later the upper third of the egg is overspread with pinkish-brown.

LARVA.—The newly hatched larva, 4 mm. long and tapering slightly towards the posterior end, is pale apricot in colour. The head is pale-brown with darker markings and a rugose surface. Two pairs of horns are present, one at the highest point of each side of the head, and the other about one-third down. The former pair, diverging at an angle of about ninety degrees and strongly curved backwards, are almost as long as the height of the head, while the latter, curving upwards and slightly backwards, are about half as long as the central pair. There are two minute spinous processes between each upper and side horn. A pair of brown, white-tipped, blunt processes, directed upwards in a slight curve, and diverging nearly at a right angle, is present on the last segment.

The length at the end of the first stage is 9 mm. and the general colour greenish with a brown spot on the sixth segment.

After the first moult, the larva becomes grass-green, with paler green dots, each bearing a short white hair. The upper half of the head is dark purplish-brown, the lower, pink-brown. The horns are crimson, with paler tips. The anal spines are crimson, with pink tubercles. A well-marked spot on the sixth segment is in shape somewhat semicircular, with a straight front edge, while that on the eighth is circular and sometimes obscure. Both spots are purplish-brown, the front one having a green dot towards the front edge.

The length at this stage is 12 mm.

11. **Charaxes numenes numenes**, Hew.

EGG.—The egg of this species is canary-yellow in colour, 1·5 mm. in diameter and deeply cupped on the top, but the flutings are poorly developed. They are laid singly, or in twos or threes on the upper surface of leaves of *Erythrina tomentosa* R. Br. (LEGUMINOSAE)—a tree with the Luganda name "Ekerikiti"; the shrub *Grewia mollis* Juss. (TILIACEAE) or a species near it, called "Nkomakoma" in Luganda; and an undetermined tree—"Nkuzayana" in Luganda. The first indications of germination appear at the edge of the cupping, and the mature egg is brownish-black.

YOUNG LARVA.—When newly emerged the larva eats the egg-shell. It is of the usual olive colour with a black head. After the third moult a white spot appears on the sixth segment, and the body becomes a distinct green. It is a delicate feeder and not easy to rear.

ADULT LARVA. Pl. LXXV, fig. 1; Pl. LXXIX, fig. 6.—The mature larva has a dull-green body, finely papillated, and is about 6 cm. long, with a distinctly whitish tail; and the anterior part of each segment bears four bluish-white spots, two dorsal and two lateral, arranged in four lines along the body.

There are two large dorsal spots of a pale purplish-buff colour or a dirty buffy-white. Each has two distinct black dots in its centre. The spot on the sixth segment is a three-pointed crescent, but that on the eighth is hexagonal in outline. In the last instar the spots are often a bright brick-red, but fade to a greyish-green when the larva curls prior to pupation, and within six hours they disappear entirely.

HEAD. Pl. LXXVIII, fig. 26.—The head as seen from the front resembles a rather convex plate, quadrilateral in outline, but narrower at the mouth, supporting four short (3 mm.), rough, spined horns all about the same length. They all come off about the same level along the top edge, and as between each horn and the next there is a well-developed spine, the head has an appearance somewhat like that of a comb. The whole head has a bluish tinge, with the apical third of each horn purple. There is no distinct face-line.

PUPA. Pl. LXXIX, fig. 6*a*, 6*b* (anal extremity).—The pupa is of the usual *Charaxes* form, of a translucent apple-green colour with no spots or marks of any kind. The imago emerges in fourteen days.

12. **Charaxes cithaeron**, Feld.

EGG. Pl. LXXIV, fig. 4.—So far as we have observed, there are at least three species of food-plant on which this species deposits its eggs: a thorny tree of medium size which has very tough leaves and bears hard, ochreous-coloured fruit, called *Chaetacme microcarpa* Rendle (ULMACEAE); a large foliage-tree, *Cola* sp. near *laurifolia* Mast. (STERCULIACEAE); and a common forest-tree with small compound leaves, *Craibia* sp. probably *Brownii* Dunn (LEGUMINOSAE). The last-named is also the food-plant of *Ch. xiphares nandina*, Rothsch.

The eggs are laid on the upper surfaces, and when just deposited are a beautiful, translucent cream-colour. They are large, measuring 1·75 mm. across, and almost spherical; the upper surface is slightly flattened and fluted, the rays being very narrow at their central meeting-point, but widening toward the margin of the cupping. The usual brownish line develops along the upper half as the egg matures, the entire surface becoming a greyish-brown just before the larva emerges. The egg stage lasts for eight days.

YOUNG LARVA.—As soon as the larva emerges it eats the remains of the egg-shell. It is greyish-olive in colour, with a black head which shows slight indications of horns. The anal segment carries two long brownish "tails." As the young larva feeds it turns greenish-yellow, and at the third instar becomes sage-green, papillated with white-tipped tubercles, and decorated with four lines of white spots which extend the length of the body. These spots are more thickly placed towards the front of each segment, and those along the side of the body are larger than the rest, thus forming a broken line which separates the greyish-green of the under surface from the sage-green above. The sixth segment is ornamented with a curious compound spot made up of three sections—anteriorly a three-quarter circle, followed by a long transverse oval, and this by a smaller oval, the whole being a dirty grey outlined with dark blue, the border itself decorated with glistening sky-blue stippling. The spot resembles a pot with a knobbed lid on the top.

HEAD OF YOUNG LARVA. Pl. LXXVIII, fig. 22.—The head presents the outline of a cone with its truncated apex towards the mouth, while the upper side or base carries the four horns, each lateral pair separated by a single spine. The horns are much tubercled, black-tipped, and with a triangular

black mark at the front of the base. A whitish-yellow line extends down the outer aspect of the lateral horns and is continued along the outline of the face.

MATURE LARVA. Pl. LXXVIII, fig. 23; Pl. LXXX, fig. 4.—In the final stage the larva becomes darker green, and of a more uniform colour, although the dorsal spot remains constant. The head (Pl. LXXVIII, fig. 23) becomes less angular and the horns more robust; the basal black disappears so that the whole head, with the exception of the marginal streak, which remains yellowish-white, is now green.

PUPA. Pl. LXXX, fig. 4*a*.—This is of the usual *Charaxes* type, pale translucent green over the head and thorax, and darker green on the abdominal segments. The abdomen is markedly convex, so that it projects further than the thorax. Ornamentation is limited to a row of small blackish, spiracular lines on the abdomen; two diffuse white areas on the wing-cases; and three whitish-blue oblique thoracic marks which meet along the mid-dorsal line, forming acute angles which point towards the head. The pupal stage lasts eighteen days, as a general rule, but some pupae carry over for six months.

HABITS.—This species is an inhabitant of the forest country, and is seen in suitable localities from the Coast to Eastern Uganda. The coastal form * is rather more brilliant in colour than that found inland. Males are far more in evidence than females, and the latter are seldom seen except when feeding at some oozing wound in a tree. The males are easily baited with any evil-smelling fowl- or animal-droppings.

13. **Charaxes tiridates tiridates**, Cram.

EGGS.—This species lays on the leaves of a species of *Grewia* (TILIACEAE) or on *Hibiscus calycinus* Willd. (MALVACEAE), known in Luganda as "Kinsambwe." The eggs are large and creamy-white in colour, not quite spherical, being 2 mm. in width and slightly less in depth, due to the presence of a shallow, well-fluted depression on the top.

YOUNG LARVA.—As soon as the young larva has emerged from the egg it devours the remains of the egg-shell. In this stage it is dull olive-brownish in colour, with a black head. At the first moult it becomes greener, and the head takes on a mottled appearance; at the third instar it turns a leaf-green and a whitish spot develops on the sixth segment.

MATURE LARVA. Pl. LXXV, fig. 4.—In the final stage the full-fed larva is a rich, dark green with finely papillated surface; the sixth and eighth segments are each dorsally ornamented with a purply-buff or white spot, that on the former having a crescentic outline with a slight pointed projection in the centre of the concavity, that on the eighth being somewhat hexagonal. In some richly-coloured examples, these spots are brick-red. The fore-part of each segment bears four or two whitish or bluish spots, arranged as a row along the lateral aspect, forming a broken spiracular line.

HEAD. Pl. LXXVIII, fig. 20.—The face is markedly convex and somewhat square in outline. There are four horns, which, having squat bases, appear to be shorter than they really are. These horns curve slightly inwards. There are two spines between the central pair and one between each of these and the lateral ones. The horns and spines are very rough, with projections all over their surfaces, but more especially in front and laterally.

* *Charaxes cithaeron kennethi*, Poult. (*Proc. III Internat. Entom.-Kongr.*, II, 1926, p. 539, n. 15). The relation of the West Kenya and East Uganda races to *c. cithaeron*, Feld., and *Ch. brevicaudatus*, Schultze, awaits investigation (*ibid.*, p. 571, n. 30).

Pupa.—The pupa is of the predominant type, with close-set head, well-developed wing-cases and marked convexity of the dorsal surface of the abdominal segments. There is little or no ornamentation.

Habits.—Males of this species are exceedingly common along the forest roads, being found in numbers on every bit of stinking dung. They can even be attracted to decomposing fish entrails. Females on the other hand are comparatively scarce and are generally to be seen hunting around for their food-plant; their flight is then laboured and slow or gliding.

14. **Charaxes eupale dilutus**, Rothsch.

Egg.—The eggs of this species are small, measuring 1 mm. in diameter; pearly white in colour, with the fluted cupping not well marked. They are laid singly on the upper surface of the leaves of a thorny creeper, *Scutia Commersonii* Brongn. (Rhamnaceae), "Kirobo" in Luganda, which grows at the edges of the forest. The larva has also been found feeding on *Albizzia Brownei* Walp. (Leguminosae). Development first appears in the cupping and the mature egg is a greyish black. It hatches out in seven days.

Young Larva.—The young larva devours the shell and in the first stage is of the usual olive-yellow colour with black head. It is by no means easy to rear, due in part to the fact that it will feed only on very fresh leaves, and the food-plant withers quickly after it is gathered.

Adult Larva.—The mature larva is about 2 cm. long, with a very finely papillated body of a dull grass-green colour. The markings vary in appearance. At the beginning of the last instar, each segment bears four rings of fine white stippling. Towards maturity these become yellowish, but there appear to be no body-marks, although one specimen showed faint indications, on the sixth segment, of a V-shaped mark as in the larva of *Ch. etheocles*. There is a fine yellow body-line starting from the second segment and reaching the tail.

Head.—The head as seen from the front resembles a somewhat egg-shaped plate with its broad end uppermost, surmounted by four long thin horns, the two central being 4 mm. and the two lateral 3 mm. in length. All four are finely spined and a uniform grass-green in colour, as is the head itself. There is no distinct face-line.

Habits.—This is an extremely common species, and like the male *etheocles*, is met with in great numbers on every collection of leopard-dung by the roadsides, where they can be easily picked off by hand. Females are remarkably scarce.

15. **Charaxes paphianus subpallida**, Joic. & Talb.

Egg.—This species oviposits on the upper surface of the leaves of a thorny creeper, *Pterolobium lacerans* R. Br. (Leguminosae); also on the allied *Acacia* sp. near *Goetzii* Harms. Both these and other similar thorny plants are known by the Luganda name "Kauli." Both are food-plants of *Ch. baumanni*, and the first-named of *Ch. anticlea*. The egg is pearly-white in colour with the usual fluted cupping on the top poorly defined. It hatches out in seven days.

Young Larva.—The newly emerged larva does not seem to eat the shell. It is of the usual olive-yellow colour with a black head. In six days it has assumed the greenish tint and indications of the characteristic side-markings are seen.

1. varanes

2 brutus.

3 anticlea

4 cithaeron.

5 candiope.

6 etheocles

7 baumanni

V. G. L. van Someren, photo. Vaus & Crampton, Ltd.

EGGS OF CHARAXES.

1. numenes

4. tiridates

2. castor

5. etesipe

3. pollux

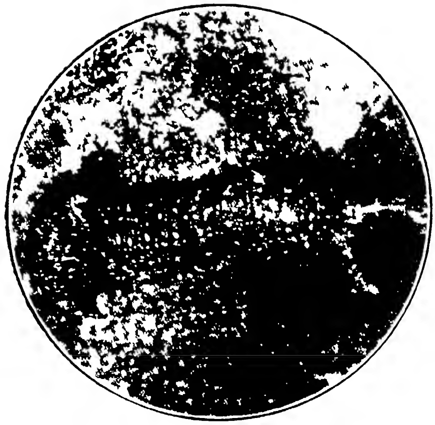
6. brutus

V. G. L. van Someren, photo. *Vaus & Crampton, Ltd.*

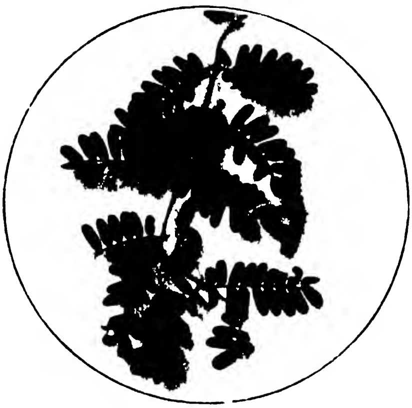
LARVAE OF CHARAXES.

Figs. 1, 2, 4, 5 half natural size, 3 and 6 greatly enlarged.

1. C. candiope.



4. C. candiope (newly hatched).



2. C. neumanni.

5. C. fulvescens monitor.

3. E. ansellica.

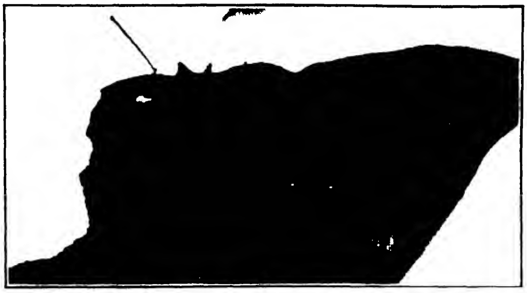
6. C. varanes.

V. G. L. van Someren, phot. Vaus & Crampton, Ltd.

LARVAE OF EUXANTHE (Fig. 3) AND CHARAXES.

Figs. 1, 3, 5, 6 about three-quarters natural size; 2 about half; 4 greatly enlarged.

1
Palla ussheri



2
Palla ussheri

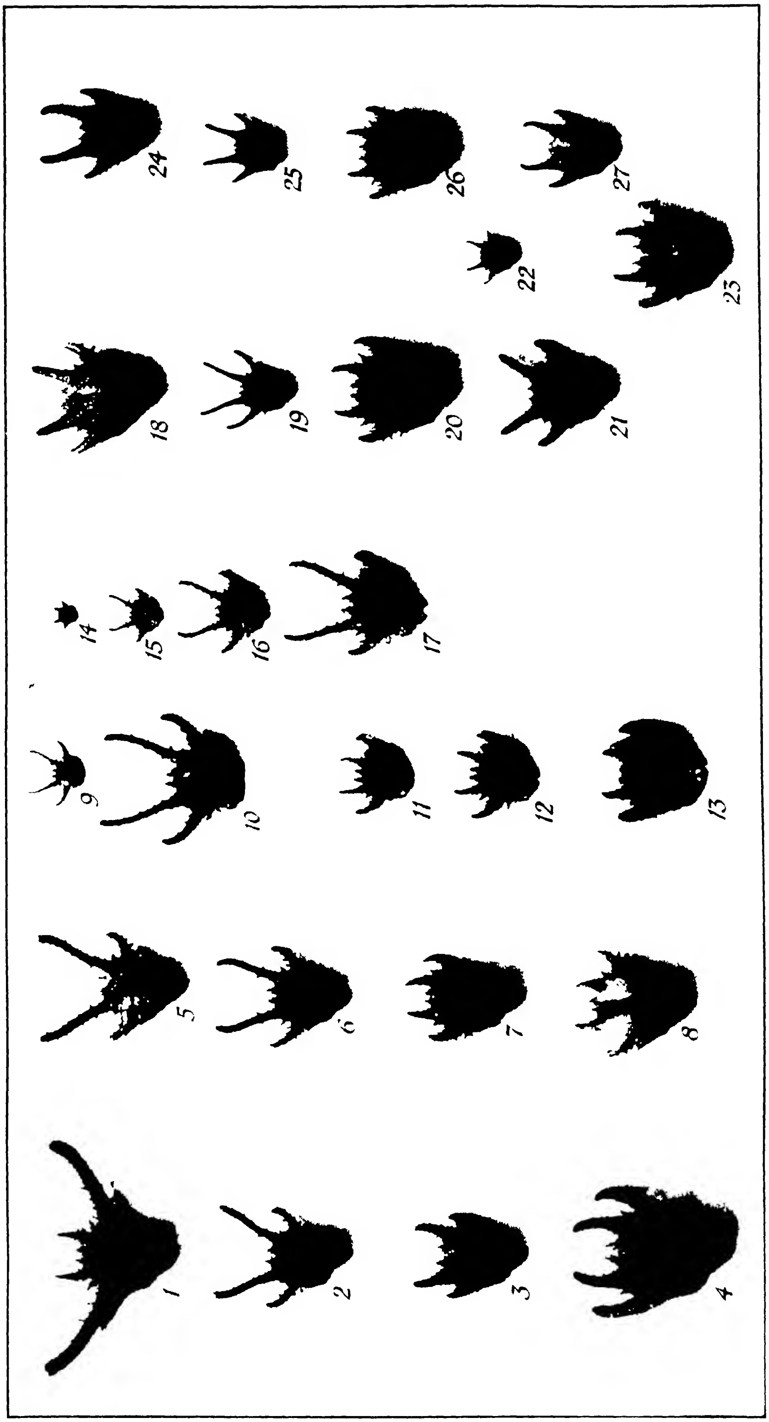
3 Ch fulvescens

4 Ch ansorgei

V. G. L. van Someren photo 5 Ch ansorgei *[illegible] Crampton Ltd*

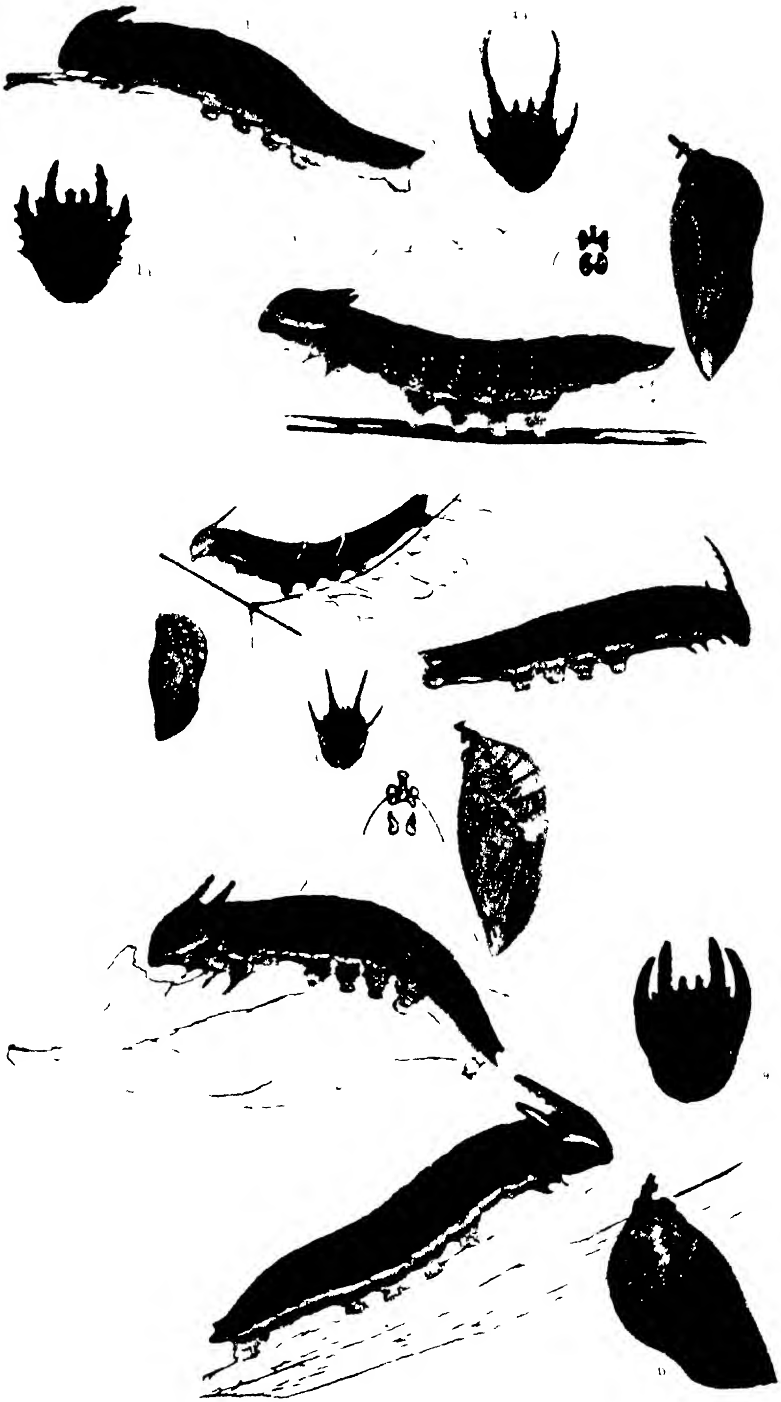
LARVAE OF PALLA AND CHARAXES

All figures natural size except figure 3 (about three quarters)



V. G. L. van Someren, photo *Vaus & Crampton, Ltd.*

CAST HEADS OF EUXANTHE (Fig. 1) AND CHARAXES
Figures 1—8 natural size, all others slightly enlarged



LARVAE AND PUPAE OF CHARAXES, EUXANTHE AND PALLA

All the [illegible]

Adult Larva.—When fully grown the larva is about 2·5 cm.–3 cm. long; the body is finely papillated and of a dark-green colour with striking black stripes, one on each segment. Under a low magnification each mark is seen to consist of an oval area enclosed by a fine black line, the oval being set sloping upwards and backwards on the side of each segment, with the anterior half light-green and the posterior jet-black. These oblique marks just fail to meet in the mid-dorsal line of segments one to eight, but they approach closer and closer until, on the ninth segment, they unite to form a crescent. The black part of the marks on segments four, five, six and seven are the widest, those before and after becoming thinner towards the head and tail.

Head. Pl. LXXVIII, fig. 19.—The face is most characteristic, resembling a plate with the outline of a truncated elongate cone with its base uppermost, surmounted by two long (5 mm.), central horns, slender and green in colour, with black tips, and two shorter (3 mm.) lateral horns which are uniformly green. The face is light-green covered with fine papillae and divided by six dark-green, nearly black lines, which, arising from the bases of the horns, pass downwards and converge towards the mouth. Of these lines two arise from the base of each central horn, and one each from the laterals.

Pupa.—The pupa is light-green, similar in form to that of *Ch. anticlea*, with no marks or spots. The imago emerges in fourteen days.

Habits.—The larva when not feeding lies, with head raised, along the stalk on an area well spun over with silk.

The imago frequents open places in thick forest and is fond of resting on some prominent leaf in the sun. If disturbed it flies off, but tends to return to the same leaf time after time. It does not seem to be attracted by the usual baits.

16. **Charaxes etesipe etesipe**, Godt.

Egg.—The eggs of this species are 2 mm. in diameter and are laid indiscriminately on the upper or lower surface of leaves of quite small Castor-oil plants, *Ricinus communis* L. (Euphorbiaceae), found growing in the cultivated fields on the outskirts of the forest; also upon *Phyllanthus meruensis* Pax (Euphorbiaceae). As many as twelve to eighteen eggs have been counted on one leaf.

The egg is of the usual form, a sphere with a fluted depression on the top. When first laid it is pearly-white, but as development proceeds it becomes dark brown. The larva hatches in eight days.

Larva. Pl. LXXV, fig. 5; Pl. LXXX, figs. 2 and 2*a*.—The young larva, which does not eat the egg-shell, is pale olive in colour with a black head on which the horns are only slightly indicated. It starts feeding at once and grows rapidly. When half-grown it is entirely green with the exception of the tips of the horns, which are black, and the tails, which are brownish. The mature larva is 5–6 cm. long with a dull bluish-green body, covered with fine papillae with white points. A distinct white-stippled line separates the green of the back from the pale whitish under surface of the body. The dorsal aspect of the sixth and the eighth segments is usually ornamented with a conspicuous grey spot, varying somewhat in shape, but most frequently resembling a three-pointed crescent, or less commonly a figure of quadrilateral shape. The spot on the eighth segment is sometimes missing.

Head. Pl. LXXVIII, fig. 3; Pl. LXXX, fig. 2*b*.—The face, which is somewhat hexagonal in outline and is surmounted by two central tubercles,

bears four horns. Two of these, which are long (4 mm.), thick, and finely toothed, arise from the upper corners, and two, which are slender and short, from the side angles. The general colour is green, with the tips of the horns blue. There is no distinct face-line. When the larva curls just prior to pupation, the colour changes—the dorsal spots disappear and the body becomes somewhat translucent. In twelve hours bold lines are visible which correspond to the marks which subsequently appear on the pupa. In another twelve hours the larval skin is shed.

PUPA. Pl. LXXX, figs. 2*c*, 2*d*, 2*e*.—The pupa is a very striking object, deep-green in colour with bold white or yellow marks and lines (see coloured figure, Plate LXXX). The pupal coloration bears apparently no relation either to sex or variety of the imago.

HABITS.—This common species, which generally breeds in the months of July and August, has been found to be a most prolific egg-layer. The larvae appear to be very susceptible to dry heat, and in dry seasons the mortality amongst them and the eggs is considerable. After feeding they retire to the under surface of the leaf, where they rest on a spot which has been well spun over with silk.

The forms of female, which are remarkable and in many cases mimetic,* will be referred to in detail in a subsequent paper.

With this species also, males are most frequently captured, as the females are more retiring and chiefly found hovering round their food-plant. The males are attracted to bait and vie with one another in securing the most savoury morsel.

17. **Charaxes anticlea adusta**, Rothsch.

EGG. Pl. LXXIV, fig. 3.—*Ch. anticlea adusta* lays its eggs on the leaves of a thorny creeper, *Acacia* sp. near *A. Goetzi* Harms. (LEGUMINOSAE), with the Luganda name "Kauli." This plant, which is closely related to *Pterolobium lacerans*, is also the food-plant of *Ch. paphianus*. The egg, which measures 1 mm. × 0·75 mm., is ovoid, with a slight depression on the top. This depression is fluted, especially at the margin. As development proceeds the creamy-white colour of the egg develops a brownish ring just below the margin of the depression.

LARVA.—The young larva emerges in seven to ten days and is at first strikingly like that of *Ch. etheocles*, but very much smaller. At the third moult it is still very like *etheocles*, being green with two dorsal marks on the sixth and eight segments. These marks are more coarsely papillated than the rest of the segmental surface and appear rough to the naked eye. Each mark is outlined posteriorly with black. The lateral body-line is yellowish.

HEAD. Pl. LXXVIII, fig. 27.—The head is distinctive, having a well-marked depressed line marking the division between the lateral halves. The bases from which the horns arise are rather angulated, giving a marked hexagonal outline to the head. The horns are purplish-brown in colour and relatively long, being three-quarters of the length of the head. The central horns are longer than the lateral ones.

The larval stage lasts fourteen days.

PUPA.—The pupa is of the usual *Charaxes* form, about 16 mm. long, and much stippled anteriorly with white markings, especially near the margins of the wing-cases. The imago emerges in ten days. As is commonly the

* See *III Internat. Entom.-Kongr.*, II, 1926, pp. 548, 549, and footnotes.

case, the red-pigmented scales of the wing are first seen through the pupa-case, to be followed some time after by the black.

HABITS.—*Ch. anticlea* is extremely plentiful where it occurs, the males being particularly abundant and much in evidence on every bit of leopard-dung or other equally odoriferous bait. One can capture the feasting insects with the finger and thumb with the greatest ease.

The larvae are rather difficult to rear on account of the fact that the food-plant, when cut, withers very quickly unless it is kept in a glass box.

18. **Charaxes baumanni**, Rogenh.

EGG. Pl. LXXIV, fig. 7.—There are two food-plants known to us, but the one most sought after is a thorny creeper, *Pterolobium lacerans*; the other, only slightly less thorny but equally objectionable to man, is a species of *Acacia* near *A. Goetzi* Harms. Both these LEGUMINOSAE are also food-plants of *Ch. paphianus*.

The eggs, which measure 0·75 mm., are laid on the upper or under surface of the leaves and when first deposited are white, becoming creamy when dry. The developmental mark first appears at three-quarters of the distance from the base to the summit of the egg and thence spreads to the crown, entirely covering the flattened top and obliterating the slight fluting which decorates it.

LARVA. Pl. LXXVI, fig. 2; Pl. LXXIX, fig. 3.—The larva emerges in ten days and makes the first meal off the remains of the egg-shell. Having eaten this it selects a couple of contiguous leaves and covers an area with silk, always retiring to this spot between meals. The larva is at first yellowish, with a blackish head and brownish tails. At the second moult the colour is bright grass-green, the body-line whitish, while the head is lighter green. Dorsal marks appear after the second instar and persist up to the time of pupation. The mature larva is brilliant grass-green, each segment bearing an oblique line of a lighter tint. This line, on the sixth and eighth segments, is raised and cadmium-yellow in colour, outlined anteriorly with whitish. The body-line remains whitish or pale-green. The under surface of the body is pale greenish. The larva pupates at about the eighteenth day.

HEAD. Pl. LXXVIII, fig. 25; Pl. LXXIX, fig. 3*a*.—The head is remarkable for the length of the straight horns. The face is oval in outline and carries on its upper third four horns and four spines. The latter are crimson or red, while the terminal half of the horns is orange-red shading to yellowish-green at the base. The yellow of the lateral horn is carried down the margin of the face and is accentuated by being outlined posteriorly with a blackish streak. The mouth-parts are yellow.

PUPA. Pl. LXXIX, fig. 3*b*.—The pupa is typically *Charaxes*-like—pale apple-green in ground-colour, slightly darker on the thorax, somewhat keeled on the lateral aspect of the head, and ornamented on the abdominal segments with three rows of yellowish spots. The imago emerges in about ten days.

HABITS.—This little *Charaxes* appears to be rather local and not often met with except in the vicinity of its food-plant or at some fermenting, oozing wound in a tree.

19. **Charaxes etheocles etheocles**, Cram.

EGG. Pl. LXXIV, fig. 6.—The eggs are 1 mm. in height and diameter, clear canary in colour, with the top cupped and fluted as usual. Development is

first indicated by a brown area in the cup, and later the mature egg becomes dark-brown. The eggs of this species are laid either singly or often two together on the upper surface of the leaves of at least two species of *Albizzia*; *Alb. Brownei* Walp., and *Alb. fastigiata* E. Mey. (LEGUMINOSAE)—named in Luganda "Nongo" and "Mugavu," respectively.

YOUNG LARVA.—The larva hatches out in seven days and has the usual olive body with a black head. It feeds best on the more mature leaves, especially if they be kept damp, and it is not difficult to rear. The larvae undergo the usual changes and at the third moult the characteristic marks of the group appear.

ADULT LARVA.—The mature larva is about 3·5–4 cm. long and dull sage-green in colour, smooth-skinned, and with a faint yellow body-line extending from the second segment to the tail. There may be either one or two dorsal spots, white or yellow in colour. If one only be present it is borne by the sixth segment and is either a line in the form of a half circle concave in front, or a V with a slight interruption at the apex. These lines are about 0·5 mm. thick and have anteriorly a fine black edging which does not quite reach the ends.

We have carefully noted these marks and cannot detect that they have any sex or varietal significance.

HEAD. Pl. LXXVIII, fig. 24.—The head is somewhat oblong with the usual vertical groove and finely papillated surface. From the sides two short (2 mm.), rough horns run upwards and slightly outwards, while from the top two long (4 mm.), thin horns run upwards with a slight curve inwards at the tips; they are papillated and bear fine serrations posteriorly. The tips of the horns are maroon-coloured. The distinct yellow face-lines start from the bases of the lateral horns, and, running downwards, meet at the mouth. The mouth-parts are brown.

The larva often spins a web of silk over the surface of two or three leaves which are curled over and thus form a shelter from the heat.

PUPA.—The dull, translucent green pupa is of the usual shape, finely rugose, and bearing along the posterior border of the wing-cases a narrow yellow line, which passes on to encircle the head-case. There remains no trace of the larval marks, these disappearing entirely when the caterpillar curls prior to pupation.

The imago emerges in twelve to fourteen days.

HABITS.—This species is exceedingly common, the males being found in numbers on every heap of leopard-dung on the open roads, or feeding on the moist areas. The females are seen only in the open forest near the larval food-plant. They seem to prefer to lay their eggs on the young root-shoots, one to two feet high, of *Albizzia Brownei* found in the cultivated areas of the forest, or on the low branches of *Alb. fastigiata*.

The subject of the various forms of both male and female is being dealt with at a later date.*

20. **Palla ussheri interposita**, Joic. & Talb.

EGG.—The eggs of this species are white or creamy and very small for the size of the insect, being only about 1 mm. in diameter. They are laid singly on the leaves of a creeper, *Porana densiflora* Hallier f. (CONVOLVULACEAE), with the Luganda name "Kiwubawuba," and somewhat resembling a Pepper

* See *III Internat. Entom.-Kongr.*, II, 1926, pp. 552–562.

Vine; also on *Toddalia aculeata* Pers. (RUTACEAE). When first deposited they are spherical, but very soon become irregularly depressed on the top just as in eggs of certain SPHINGIDAE.

YOUNG LARVA.—The eggs hatch in ten days; the newly emerged larva is brown with a black head, and the slightest trace of tubercles in the positions where the horns eventually develop.

At the second week the larva enters the second instar (length 1·5 cm.) and is now light brown, with light blue-green patches beginning to appear on the sides and dorsum; the horns, which are very stumpy and not over 2 mm. long, show a slight tendency to bifurcation.

At the third week a brown patch develops on the mid-dorsal line of the first to the sixth segments; the horns are now 4 mm. long and a little recurved; the lateral body-frill (described below) slightly evident.

MATURE LARVA. Pl. LXXVII, figs. 1, 2; Pl. LXXX, figs. 1, 1*a*.—In the last instar the full development of the extraordinary shape of the larva is reached. The coloration and shape are highly cryptic, the colour being brown and green like a half-dead leaf, and the body having a lateral expansion or frill extending from the first to the last segments, chiefly developed and slightly curved upwards in the region of the sixth to eighth segments. The ground-colour of the larva is a light-green, decorated on the dorsum with a patch of dark brownish-green, which colour extends from the third to the ninth segments and is carried outward to the margin of the expanded frill. There is in addition a very dark brown area on the edge of the first two segments. Most of the segments bear two white dorsal spots. The greater part of the under surface is rich orange, shading to pink anteriorly and posteriorly. The larva in an attitude of defence is very curious, the fore- and hind-parts of the body being raised well above the resting-surface, and the fourth and fifth segments arched.

HEAD. Pl. LXXX, fig. 1*b*.—The head is very dark brown or jet-black, somewhat triangular in front view and surmounted by a strong pair of black recurved horns with widely bifid ends.

PUPA. Pl. LXXX, figs. 1*c*, 1*d*, 1*e*.—The pupa is very distinctive in form and colour, being an opaque apple-green, with bold brown lines along the lateral margin of body and wing-cases, with finer brown lines and spots on the ventral surface and darker green lines on the dorsal surface of the thorax. The abdominal segments are markedly convex ventrally and expanded laterally. The pupal stage lasts from seven to ten days.

HABITS.—This is a purely forest species, but rather local and restricted to certain localities within the forest. Males far outnumber the females. or would appear to do so judging from the numbers seen, but whereas the males are fond of disporting themselves in the sunny glades, or will readily come to bait, the females are very retiring and seldom in evidence. The females, which are very different in colour from the males, are certainly mimetic of *Ch. fulvescens monitor.*

The restricted distribution of the species is undoubtedly governed by the food-plant.

21. **Euxanthe ansellica**, Btlr.

EGG.—The eggs of this butterfly are laid singly on the upper surface and near the midrib of the more mature leaves of a forest-tree with the Luganda name "Nkuzanyana"—the food-plant of many species of *Charaxes*, also of

Euphaedra and *Euxanthe crossleyi*, Ward. The egg is bright canary-yellow in colour and 2 mm. in diameter, resembling those of the *Charaxes* group in being almost spherical with the top of the sphere depressed with a markedly fluted dimple.

In two days a brown mark develops at the rim of the depression, and the whole egg gradually becomes black, the larva hatching out in from seven to ten days. It starts life by devouring the egg-shell.

Young Larva.—When newly emerged the young larva resembles that of a *Charaxes* in having a pale olive body and black head which, under a low magnification, is seen to be covered with fine papillae. At this stage the larva has no body-spots, but with each successive moult the body assumes a greener tint. At the third moult the spots appear as white elevated marks and the whole head becomes paler. The young larvae are difficult to rear and their growth at first is very slow, although rapid later on.

At all stages they prefer the tough mature leaves to those of the young shoots. After each moult the horns are quite white, but soon darken to a grey-brown.

Mature Larva. Pl. LXXVI, fig. 3; Pl. LXXX, fig. 6.—The adult larva has a smooth, broad, somewhat flattish body, sage-green in colour, with two enamel-like elevated spots, oval in shape, placed transversely across the dorsal surfaces of the sixth and eighth segments, each spot having two fine black dots placed side by side in its centre. The body-line is white, and this part is so well developed as to form a well-marked frill on each side of the body, extending from the head to the anal segment. The "tails" are white. In some specimens, the horns, the dorsal spots and the frills become a rusty-red colour. (See Pl. LXXX, fig. 6.)

Head. Pl. LXXVIII, fig. 1.—The head in front view resembles a circular plate covered with fine papillae. A central groove, commencing between the two median spines, passes vertically downwards, and at about the centre of the disc divides into two, thus enclosing a triangular area just above the mouth-parts. The whole is coloured dark green. From the junction of the middle and upper thirds of the circle there arises on each side a thick blunt-ended cylindrical horn, greyish-white in colour and covered with fine papillae, which, on the inner side of the posterior aspect, become a series of blunt spines. The horns are each 9 mm. long, widely divergent and curved upwards and inwards. Between these and along the top of the head are four short straight horns, also much papillated; the outer ones measure 4 mm., the two central, 2 mm. A broad white face-line starts at the base of the outer short horn and runs round the circumference of the plate, passing above the black mouth-parts. Also, from the base of these horns, two fine white lines run downwards, converging towards but not reaching the mouth.

Pupa.—Pl. LXXX, figs. 6*a*, 6*b*.—The pupa has a very deformed appearance due to a prominent dorsal hump extending from the first to the third abdominal segments, and to a similar protuberance of the dorso-thoracic region. The whole pupa is strongly ventricose, with the wing-cases prominent and well defined. The colour is dark green with splashes of white marbling on the dorsal and ventral surfaces.

Habits.—The imago is slow in flight and easily captured, as it has a habit of resting, with its wings folded, head downwards on the festoons of dried creepers in the open patches of forest. Males are also attracted to damp mud and to baits.

Explanation of Plates LXXIV–LXXX.

Plate LXXIV.

Eggs of *Charaxes.*

Fig. 1. Egg of *Charaxes varanes* (Nairobi).
2. ,, ,, *brutus brutus* (Nairobi).
3. ,, ,, *anticlea adusta* (Jinja).
4. ,, ,, *cithaeron* (Nairobi).
5. ,, ,, *candiope candiope* (Nairobi).
6. ,, ,, *etheocles etheocles* (Nairobi).
7. ,, ,, *baumanni* (Nairobi).

Plate LXXV.

Larvae of *Charaxes.*

Fig. 1. Larva of *Charaxes numenes numenes* (Jinja).
2. ,, ,, *castor castor* (Jinja).
3. ,, ,, *pollux pollux*, newly hatched (Nairobi).
4. ,, ,, *tiridates tiridates* (Jinja).
5. ,, ,, *etesipe etesipe* (Jinja).
6. ,, ,, *brutus brutus*, newly hatched (Nairobi).

Plate LXXVI.

Larvae of *Charaxes* and *Euxanthe.*

Fig. 1. Larva of *Charaxes candiope candiope* (Nairobi).
2 ,, ,, *baumanni* (Nairobi).
3. ,, *Euxanthe ansellica* (Jinja).
4. ,, *Charaxes candiope candiope*, newly hatched (Nairobi).
5. ,, ,, *fulvescens monitor* (Jinja).
6. ,, ,, *varanes vologeses* (Jinja).

Plate LXXVII.

Larvae of *Palla* and *Charaxes.*

Figs. 1 & 2. Larva of *Palla ussheri interposita* (Jinja).
3. ,, *Charaxes fulvescens ? acuminatus* (Kikuyu Escarpment).
4. ,, *Charaxes ansorgei*—red-spotted variety—above, and ochreous-spotted variety—below (Kikuyu Escarpment).
5. ,, *Charaxes ansorgei*—white-spotted variety (Kikuyu Escarpment).

PLATE LXXVIII.

Cast heads of *Charaxes* and *Euxanthe* larvae.

FIG. 1. Cast head of *Euxanthe ansellica* (Jinja).
2. ,, ,, *Charaxes varanes vologeses* (Jinja).
3. ,, ,, ,, *etesipe etesipe* (Jinja).
4. ,, ,, ,, *castor castor* (Jinja).
5. ,, ,, ,, *fulvescens monitor* (Jinja).
6. ,, ,, ,, *varanes* (Nairobi).
7. ,, ,, ,, *pollux pollux* (Jinja).
8. ,, ,, ,, *brutus brutus* (Jinja).
9. ,, ,, ,, *fulvescens ? acuminatus* (Kikuyu Escarpment).
10. ,, ,, ,, ,, ,, ,, ,,
11–13. ,, ,, ,, *ansorgei* (Kikuyu Escarpment).
14–17. ,, ,, ,, *varanes* (Nairobi).
18. ,, ,, ,, *jasius epijasius* (Jinja).
19. ,, ,, ,, *paphianus subpallida* (Jinja).
20. ,, ,, ,, *tiridates tiridates* (Jinja).
21. ,, ,, ,, *candiope candiope* (Nairobi).
22–23. ,, ,, ,, *cithaeron* (Nairobi).
24. ,, ,, ,, *etheocles etheocles* (Nairobi).
25. ,, ,, ,, *baumanni* (Nairobi).
26. ,, ,, ,, *numenes numenes* (Jinja).
27. ,, ,, ,, *anticlea adusta* (Jinja).

PLATE LXXIX.

Larvae and pupae of *Charaxes*.

FIG. 1. *Charaxes brutus brutus* : 1, larva; 1*a*, head (Jinja).
2. ,, *castor castor* : 2, larva; 2*a*, head; 2*b*, pupa (Jinja).
3. ,, *baumanni* : 3, larva; 3*a*, head; 3*b*, pupa (Nairobi).
4. ,, *varanes vologeses* : 4, larva; 4*a*, head (Jinja).
5. ,, *jasius epijasius* : 5, larva; 5*a*, pupa; 5*b*, anal extremity (Jinja).
6. ,, *numenes numenes* : 6, larva; 6*a*, pupa; 6*b*, anal extremity (Jinja).

PLATE LXXX.

Larvae and pupae of *Charaxes*, *Palla*, and *Euxanthe*.

FIG. 1. *Palla ussheri interposita* : 1 and 1*a*, larva; 1*b*, head; 1*c*, 1*d* and 1*e*, pupa (Jinja).
2. ,, *etesipe etesipe* : 2, larva; 2*a*, larva, preparation to pupation; 2*b*, head; 2*c*, 2*d* and 2*e*, pupa (Jinja).
3. *Charaxes pollux pollux* : 3, larva; 3*a*, head (Nairobi).
4. ,, *cithaeron* : 4, larva; 4*a*, pupa (Nairobi).
5. ,, *fulvescens monitor* : 5, larva; 5*a*, pupae (Jinja).
N.B.—In figure 5 the dorsal spots should be on segments 6, 8 and 10, and not as depicted.
6. *Euxanthe ansellica* : 6, larva, immature; 6*a*, 6*b*, pupa (Jinja).

TWO NEW DRAGONFLIES (ORDER ODONATA)

By Lt.-Col. F. C. Fraser, I.M.S.

[Read June 2nd, 1926.]

With Three Text-figures.

Amongst a large amount of unnamed material from Africa in the British Museum, I have found a single incomplete specimen of a very remarkable dragonfly. The base of the hind-wing is not only simple and archaic in nature, but bears along its basal margin a series of spines, terminating in a comparatively robust one on the angular point of the termen. The anal triangle is also entirely absent, both this feature and the presence of wing appendages being unique, the first in the family Gomphidae, and the second in the whole of the order Odonata.

A second species in my own collection, also from Africa, is remarkable on account of its close resemblance in general facies, size, markings and anal appendages to *Lamellogomphus biforceps* (Selys), and also by the 9th abdominal segment being shorter than the 10th, a character shared only by *Crenigomphus*, another African genus of the Gomphidae. The new species does not, however, belong to this genus, as in all other respects it differs widely, so much so, that it is difficult to discover even a close relationship.

I propose to erect two new genera to accommodate these species, *Echinopterogomphus* and *Libyogomphus* respectively. Fór the opportunity of examining the former, I have to thank the authorities of the British Museum. The two photos accompanying this paper, were taken for me by Mr. Herring of the same institution.

Genus **ECHINOPTEROGOMPHUS**, gen. nov.

Small species of Gomphines not clearly related to any other known genera, coloured black with yellow markings. Head comparatively large, especially the eyes; thorax small; legs moderately long, hind femora extending to middle of 2nd segment and armed with a row of very small, very closely-set spines; abdomen slender, tumid at base (incomplete, the last seven segments missing); wings long and narrow, the hind not markedly broader than the fore, especially at the base, which in the hind-wings is very oblique and without any vestige of anal triangle, slightly concave and with tornus nearly right-angled, a row of five small spines near middle of wing base and a much more robust one situated at the tornus. A single row of postanal cells in fore-wings, two to three rows in the hind, the first postanal cell entire. All trigones, hypertrigones and subtrigones entire, trigone of fore-wing with distal and basal sides slightly longer than costal, that of hind-wing subequilateral; basal subcostal nervures absent in all wings; two rows of discoidal cells in fore-wing to level of node; three nervures between *M i–iii* and *M iv* in fore-wing, only one in the hind; sectors of arc approximated and nearly fused immediately after origin for a long distance; *Cu i* in fore-wing flat, *Cu ii* not pectinate, only a single row of cells between it and border of wing, *Cu i* and *Cu ii* in hind-wing parallel to one cell's distance from border of wing; a single row of cells between *M i* and *M ia*; forking of *M i–ii* and *M iii* symmetrical in both wings; pterostigma moderately large, equal to nearly one-third the distance from node to distal end of pterostigma, strongly braced in all wings; membrane absent; reticulation rather close.

Genitalia.—Anterior hamules long, narrow, sloping steeply back; posterior hamules short and broad; lobe broad, prominent, spout-shaped (anal appendages missing).

Distribution.—Africa.

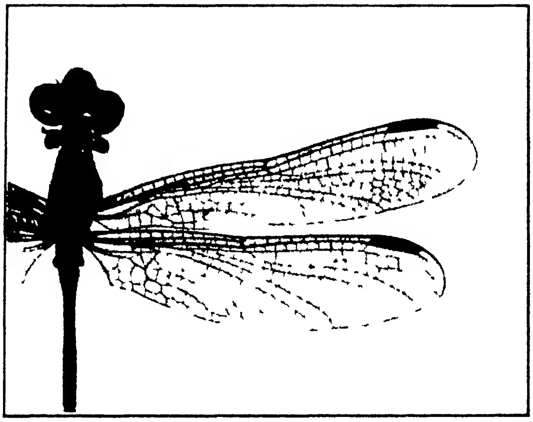


FIG. 1.—*Echinopterogomphus africanus*, sp. nov. ♂ (× 3·8).

FIG. 2.—Base of hind-wing of *Echinopterogomphus africanus*, showing marginal and tornal spines.

Echinopterogomphus africanus, sp. nov.

Male.—*Abdomen* 22 mm. (three distal segments 6 mm.). *Hind-wing* 19 mm. *Head :* labium dirty brown; labrum dark olivaceous bordered with brown; face dark brown with a transverse bluish-green stripe across clypeus and a second better-defined stripe on crest of frons; vertex and occiput dark brown, a pale bluish-green spot in centre of latter, its hinder border divided by a small notch into two

small lobes. *Prothorax* pale brown. *Thorax* olivaceous on dorsum in front enclosing a broad fusiform spot on either side, converging above, divergent below so as to enclose a triangle of the ground-colouring. Laterally greenish marked with a broad posthumeral dark brown stripe and a second narrower stripe on the second lateral suture. *Wings* hyaline; pterostigma warm brown between darker nervures. *Legs* yellowish, tibiae and distal ends of femora dark drown. *Abdomen* dark brown, the second segment with a broad transverse stripe of paler colour (probably yellow) on its basal third. Apical suture of 2nd segment black, 3rd segment with pale basal and subapical indistinct markings.

The single specimen is teneral, the adult ground-colour being probably black, and the markings greenish-yellow.

Distribution.—Port Lokko, Africa, 1.v.1912. Type in B.M.

Genus **LIBYOGOMPHUS**, gen. nov.

Large species of Gomphines coloured black, marked with bright citron yellow. Head large, frons pronounced, angulate; occiput flattened, slightly concave along the hinder border and fringed with long black hairs. Thorax robust. Legs moderately long, hind femora extending to base of 2nd abdominal segment and densely clothed with short robust spines beneath. Abdomen tumid at base and anal end, narrow and cylindrical from segment 3 to 7, segments 8 and 9 with lateral borders markedly produced, but not winged, segment 10 of even greater depth than 8 and 9. Segments 8 and 10 equal to about two-thirds the length of 7, segment 9 considerably shorter than 10. Dorsum of segment 10 raised into a prominent rounded hump. Anal appendages strongly curved, enormously elongate and forming a pincer-like group by apposition of their apices, the inferior appendage split completely to base into two closely apposed parallel laterally compressed branches. Wings rather long and broad, reticulation close; all trigones, hypertrigones and subtrigones entire; trigone of fore-wing with costal and proximal sides subequal and longer than basal, proximal side slightly angulate; trigone of hind-wing longer, its costal and basal sides meeting at a right angle, costal side longer than basal but shorter than proximal; basal subcostal nervure absent in all wings; two rows of discoidal cells in fore-wing to beyond level of node; four nervures between *M i-iii* and *M iv* in fore-wing, only two in the hind; sectors of arc separate at origin and divergent thereafter; *Cu ii* in fore-wing markedly pectinate, *Cu i* and *Cu ii* in hind-wing divaricate at termen; two rows of cells between *M i* and *M ia*; forking of *M i-ii* and *M iii* symmetrical in all wings; pterostigma small, equal to about one-fourth the distance from node to distal end of pterostigma, unbraced; membrane obsolete; base of hind-wing deeply excavate, tornus pointed. Fore-wing with one to two rows of postanal cells, hind-wing with four rows, the first postanal cell in the latter entire, extending only about halfway along subtrigone, as in genus *Gomphus*.

Genitalia.—Anterior hamules long, slender, strongly curved analward; posterior hamules robust, projecting perpendicularly from ventrum, broad at base, tapering gradually to apex, which is curved slightly forward; lobe broad, short, spout-like.

The relative length of segments 8, 9 and 10 suggests affinity to the genus *Crenigomphus*, this affinity being accentuated by the fact that both genera are restricted to the African continent. The venation, especially that of the base of hind-wing, resembles that of genus *Gomphus*, the anal appendages resemble closely those of the genera *Onychogomphus* and *Lamellogomphus*. These comparisons show how difficult or impossible it is to fix any definite relationship with any of the genera mentioned.

Distribution.—Africa.

Libyogomphus tenaculatus, sp. nov.

Male.—Abdomen (with appendages) 40 mm. *Hind-wing* 34 mm. ***Head:*** labium bright yellow clouded with brown along its free border, labrum warm reddish-brown marked with two large triangular greenish-yellow spots; bases of mandibles and clypeus citron yellow. Face brown, frons greenish-yellow above and along crest; occiput and vertex brown, free border of former thickened, dark brown.

Prothorax reddish-brown, the anterior border yellow. *Thorax* dark reddish-brown, almost black, marked with bright citron yellow as follows :—a mesothoracic collar slightly interrupted at the middle, oblique narrow ante-humeral stripes barely confluent with the mesothoracic collar. Laterally a narrow complete post-humeral stripe, a median stripe interrupted above and below so as to form three spots, and finally a narrow stripe on the middle of the metepimeron, its upper end curving forward as far as the 2nd lateral suture. *Legs* dark reddish-brown, tibiae and tarsi black. *Wings* hyaline; pterostigma dark reddish-brown between black nervures,

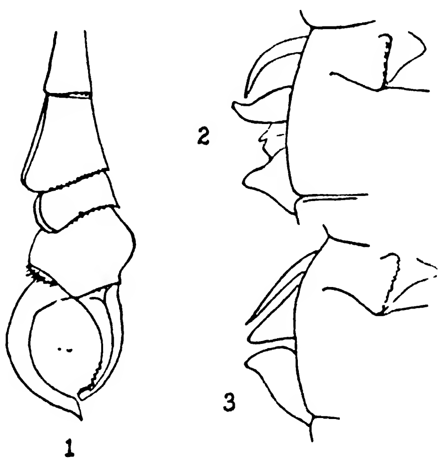


FIG. 3.—1. Last four abdominal segments of *Libyogomphus tenaculatus*, sp. nov., showing relative lengths of segments and anal appendages. 2. Genitalia of same seen in profile. 3. Genitalia of *Echinopterogomphus africanus*.

a little dilated, over about seven cells, unbraced; nodal index $\frac{11\text{-}15}{13\text{-}12}\Big|\frac{17\text{-}12}{11\text{-}12}$

Abdomen black marked with yellow as follows :—segment 1 with the sides greenish-yellow, 2 entirely yellow save for a narrow diffuse brownish annule bordering the hinder part of the jugal suture. Oreillets robust, yellow, with about seven closely-set spines along the free border. Segments 3 to 6 unmarked save for a ventro-basal streak of yellow on 3 and an apical ventral spot on 6; segment 7 bright citron yellow for its basal half; segments 8 to 10 dark reddish-yellow laterally, dark brownish-black above.

Anal appendages. Superiors with the basal half yellow, apical half dark brown, equal to nearly twice the length of segment 10, widely separated at base, converging as far as the apices, where they meet, bases broadened from above down, tapering rapidly to an obtuse point, laterally compressed, keeled along the dorsum and again on the outer side. Below the latter keel, along the apical half of appendage, a row of five closely-set spines, and beneath apex, another row of five minute, closely-set spines. Inferior appendage directed downward for rather less than its basal fourth, then rather squarely back and finally in a regular curve upward to meet

the downwardly curved apices of superiors. Thick at base, of even width thereafter and narrower, laterally compressed, the apex strongly bevelled above and ending in a fine point. The two branches closely apposed and separated right up to their origin from segment 10.

Genitalia as for genus.

Distribution.—Cameroons, Africa, October 1918. A single male in my own collection. (Female unknown.)

ON THE LIFE-HISTORY OF *CALIGO ILLIONEUS ILLIONEUS*, CRAM. (LEP., MORPHIDAE)

By L. D. Cleare, Jnr., F.L.S.,

Government Economic Biologist, British Guiana.

[Read June 2nd, 1926.]

Plates LXXXI–LXXXIII.

The insect of which the life-history is hereafter described is of common occurrence on the coastlands of British Guiana. where the larvae feed on the leaves of sugar-cane and bananas, but it never occurs in such numbers as to cause it to be classed as anything but a minor pest of these plants.

The first description of *Caligo illioneus* was published as long ago as 1779 by Cramer in his *Papillons Exotiques*, when the adult female insect was figured, while in 1873 Burmeister, in *Revue de Zoologie*, described the full-grown larva and pupa, giving figures of these stages. The ova and larvae of the closely allied subspecies *C. illioneus saltus* were figured by Guppy in his appendix to Kaye's paper on the Rhopalocera of Trinidad in *Trans. Ent. Soc.* 1904, but he gives no descriptions of the stages. He mentions, however, that they feed on banana. Apart from these scanty descriptions there appears to be no account of the biology of the species, and it is for this reason that the present paper has been prepared.

The synonymy of the species is as follows :—

Papilio illioneus, Cramer, Pap. Exot., vol. 1, p. 81, t. 52, f. A, B (fig. typ. ♀), 1779; *Morpho* (*Pavonia*) *ilioneus*, Godart, Enc. Meth. Zool., vol. 9, p. 448, No. 25, & Suppl., p. 807, 1819; *Caligo ilioneus*, Westwood, in Doubleday, Westwood & Hewitson, Gen. Diurn. Lep., vol. 2, p. 342, No. 5, 1851; *Pavonia ilioneus*, Burmeister, in Rev. Zool. (3), vol. 1, p. 39, t. 5, f. 2, 3, 1873; *Caligo ilioneus*, Staudinger (u. Schatz), Exot. Schmett., vol. 1, p. 216, t. 73 (also *C. teucer*) (part), 1887; *Potamis conspicue teucer*, Hübner, Exot. Schmett., vol. 1, t. 77 (fig. typ. ♂), 1806–16; *Caligo illionea*, Hübner, Verz. Schmett., p. 51, No. 485, 1816; *Caligo oberon*, Kirby, in Hübner u. Geyer, Exot. Schmett. Neue Ausg., vol. 1, p. 52, ♂ (part), 1901; *Caligo illioneus illioneus*, Cramer, Stichel, in Genera Insectorum, Fasc. 20*e*, p. 36, 1905; *Caligo illioneus illioneus*, Cramer, Fruhstorfer, in Seitz' Macrolep., vol. 5, p. 319, pl. 64*c*, 1912.

The distribution of the species is Colombia and Venezuela to S. Brazil (Rio), Ecuador and Peru, but the subspecies to which this paper refers is apparently limited to Guiana and northern Brazil.

Life-history.

The Egg.

Egg (Plate LXXXII, fig. 1).—The eggs are deposited on the underside of the leaf close beside the midrib, in a single row running lengthways along the leaf, usually five in number; spherical in shape, 2 mm. in diameter, and about the same height (1·9 mm.), shining pearly-white in colour (being when freshly laid nearly white), strongly ribbed with thirty-three longitudinal ribs, the intervening

spaces being marked with fine latitudinal striations. As the larva develops within the egg a thin horizontal line appears about the middle of each ovum, brownish in colour, as well as a number of small spots. Some two days before the larva emerges from the egg its movements within the egg may be distinctly observed.

The Larva.

First Instar (Plate LXXXI, fig. 1).—Recently emerged larva. Length about 9 mm. inclusive of anal processes, which are about 2 mm. long. Head amber-brown * with two conspicuous longitudinal dark vandyke-brown stripes, covered with long stout black hairs, about twice the width of the body (width of head 1·7 mm., width of body 0·8 mm.) with the long axis horizontal (length 1·5 mm., width 1·7 mm.). Body cylindrical, segments not distinct, each segment with transverse wrinkles and bearing a few short light-coloured setae; light chalcedony-yellow with four conspicuous longitudinal carmine stripes extending the entire length of the body to the base of the anal processes, the two addorsal being broader than the two subdorsal, the addorsal ones commencing behind the cervical plate, where they are somewhat broader; there is also on each side a faint narrow lateral stripe of the same colour, and just behind the cervical shield can be seen the commencement of a medio-dorsal stripe, also of carmine. Two large and very conspicuous anal processes project behind the body more or less U-shape, dark vandyke-brown in colour, each bearing three strong bristles situated one at the base, another about midway, and a third at the tip, the basal one arising from a large and prominent tubercle.

Four days after emergence a marked change in the colour of the larva takes place without any ecdysis.

After this change a broad and distinct medio-dorsal line of burnt lake appears, extending the entire length of the larva from the cervical shield to the anal extremity between the anal processes, being broadest on the first three segments where it is partly divided longitudinally by a broken white line, which may also appear faintly on other segments, and tapering gradually to the caudal extremity; the addorsal, subdorsal and lateral stripes change to a light bice green; other coloration as before. The larva now measures about 17·0 mm. in length, by 1·5 mm. in breadth. Dorsal stripe about 0·5 mm. broad.

Second Instar (Plate LXXXI, fig. 2).—Length 18·7 mm. inclusive of anal processes, which measure 3·2 mm. Length of head inclusive of processes 3·0 mm., length of largest processes 0·8 mm. Width of head 2·1 mm. In general appearance the larva is much the same as in the second stage of the previous instar, except for a marked change both in colour and formation of the head, and of colour in the anal processes. The head has now developed three pairs of processes along the top margins of the epicrania, the inner pair being largest and quite conspicuous, the second pair less so, and the third and outer pair comparatively small; the inner pair vandyke-brown at the base gradually diffusing toward the tips, the second and third pair ivory-yellow; the first and second pairs of these processes bear numerous strong setae toward the tip. The head is ivory-yellow in colour and the two stripes of the previous instar have now almost completely merged, except at the inner margins of the epicrania where there may still be seen two narrow stripes of ivory-yellow, into

* The names of colours given hereafter are from Ridgway's *Color Standards and Color Nomenclature*, Washington, D.C., 1912.

one broad stripe of vandyke-brown diffusing to and bounded by an amber-brown band extending from the eyes to the middle pair of processes. Front ivory-yellow with three amber-brown marks. Eyes black. Head covered with fine light-coloured hairs, longer toward the mouth-parts. Mandibles amber-brown.

Third Instar.—Length 30·0 mm. inclusive of anal processes, which measure 7·0 mm. Breadth 2·5 mm. Length of head 5·0 mm. inclusive of processes; length of first pair of processes 3·0 mm. Width of head 3·0 mm. The general appearance of the larva in this instar is much the same as in the previous instar, and the principal differences are to be noted in the coloration of the head, and in the disappearance of the black tip to the anal processes. The head shows three distinct bands of brown on the epicrania, a third band of vandyke-brown having now developed along the outer margin of the amber-brown band, while the narrow stripes of ivory-yellow on the inner margin have now extended down to the adfrontal suture. A fourth and very much smaller pair of processes has now developed on the head outside the third pair. The medio-dorsal stripe of the body is now divided longitudinally on every segment, being most noticeably so on the sixth, seventh and eighth segments. There is now a strong and conspicuous horn on the sixth segment in a central position in place of the small outgrowth of the previous instar, while on each of the eighth and ninth segments in the same position is a much smaller outgrowth of the same character. Stigmatal area light vinaceous-cinnamon. Entire body covered with fine light-coloured hairs. Anal processes the same colour as in previous instar, except that now there are no black tips.

Fourth Instar (Plate LXXXI, fig. 3).—Length 40·0 mm. inclusive of anal processes, which measure 8·0 mm. Breadth 4·0 mm. Length of head 8·0 mm. inclusive of processes; length of first pair of processes 3·0 mm. Width of head 4·5 mm. There is a marked change of colour in this stage. In general colour the larva is now vinaceous-buff darkening on the first two segments to a buffy-brown with a dark olive medio-dorsal stripe. The head is much the same as in the previous instar, except that there is somewhat of a diffusion of the dark outer band into the genal ivory-coloured areas and the underside is diamine-brown, while the largest processes are now ivory-yellow above, the underside being vandyke-brown. The body is vinaceous-buff with a conspicuous medio-dorsal stripe of olivaceous-black, almost black, and is more or less regularly marked with liver-brown streaks which on the dorsal areas meet at the dorsal line in each segment, widening out as they extend backwards, thus forming a more or less faintly V-shaped marking on each segment, the apex directed forward. On the lateral areas these markings can be more definitely traced into stripes, the addorsal being still well defined on the first three segments, the subdorsal (supraspiracular) being defined along its entire length, while the lateral (subspiracular) is conspicuous as a distinct ivory-yellow stripe for its entire length. Five "horns" are now present along the dorsal stripe situated on the fifth, sixth, seventh, eighth and ninth segments; that on the sixth being the largest and measuring about 2 mm. in height, the eighth and ninth being next in size but much smaller, and those on the fifth and seventh being quite insignificant. The anal processes are more or less the same general colour as the larva, being diffused somewhat with a darker shade. The underside of the body is vinaceous-brown, the legs being violet-carmine. The entire body is covered with small fine hairs of a light ivory-yellow.

Fifth Instar (Plate LXXXII, fig. 2, and Plate LXXXIII).—Length 55·0 mm. inclusive of anal processes, which measure 7·0 mm. Breadth 6·0 mm.

Length of head 11·0–12·0 mm. inclusive of processes; length of first pair of processes 4·0–5·0 mm. Width of head 5·0–6·0 mm. These, and all other measurements, were taken soon after ecdysis. The general appearance of the larva is much the same as in the previous stage except that there is now a very distinct stripe of sepia between the addorsal and the subdorsal stripes extending the entire length of the body. On each segment from the fifth to the tenth this stripe is broken into a sort of barb, the point being directed backwards. The light-coloured areas of the head are now the same vinaceous-buff colour as is the body, the processes being somewhat lighter.

The larvae gradually increased in size until their final measurements were :— Length 95·0–105·0 mm. Breadth 9·0 mm.–10·0 mm. This, however, does not represent the greatest size attained by larvae of this species, for subsequently a specimen was collected which measured 112·0 mm. long by 12·0 mm. broad.

Having first spun a small network of silk on the leaf, the larva suspends itself head downwards by the anal prolegs, the body hanging straight down, the segments at the same time becoming very distinct and the colour considerably lighter. In this position the larva rests for about twenty-four hours, when the entire larval skin is cast off and the pupa appears.

The Pupa.

The Pupa (Plate LXXXII, figs. 3, 4, 5).—Length 33·0–38·5 mm., breadth 18·0–20·0 mm. The colour is pinkish-buff finely marked with cinnamon-buff and tawny-olive, giving the whole a tawny-olive appearance, with irregular blotches of dark greyish-olive scattered over it. The wing-cases are strongly angled and stand out well from the body. About midway along the edge of the wing-cases is a double silver spot, the outer being larger than the inner part and more or less triangular in shape. The thorax is markedly humped on the dorsal surface, and a thin dark greyish-olive median line extends along the whole length of the dorsum. On each abdominal segment, extending backwards on each side of the dorsal line, is a white stripe bordered with greyish-olive, the two almost meeting on the dorsal line at the anterior end of the segment and diverging as they extend backwards, forming a more or less V-shaped marking on each segment. On the abdominal segments below the wing-cases there is also a lateral stripe of dark greyish-olive. There is a flexible joint between the fourth and fifth abdominal segments which allows considerable movement of the segments below it, as a whole, in a lateral direction.

Summary of Life Cycle.

The life cycle may be summarised as under :—

Egg period : not definitely known, but more than seven days.
Larval period : 40 to 44 days.
Pupal period : 11 to 13 days.

From five larvae that emerged from one batch of eggs three adults were obtained, of which two were males. An examination of the genitalia of the pupa of the fourth insect showed this to be a male, giving the proportion of three males to one female. One larva was accidentally destroyed.

From another lot of larvae collected a few weeks later one male and three females subsequently emerged. The ova of the first batch were collected in the month of July, and the second batch of larvae towards the end of September

and middle of October at the British Guiana Sugar Planters' Experiment Station in the vicinity of Georgetown and also in Georgetown itself.

Habits of Larvae and Adult.

On hatching, the larvae eat the egg-shell, leaving usually only the base which is attached to the leaf. The larvae throughout the greater part of the day remain motionless on the underside of the leaf, parallel to the midrib, adhering closely to the surface with their heads depressed, one behind the other, often in two groups composed of two or three larvae respectively. In the group consisting of two larvae they rest head to head, while in the group comprised of three larvae two of them will face one direction, one close behind the other, and the third will face the opposite direction head to head with the first of the other two larvae. In these positions the larvae are quite inconspicuous, their coloration and position being cryptic and protective.

In the early stages (first instar) the larvae feed intermittently during the day, but even then the majority of the feeding is done in the early morning or at night. As the larvae develop all feeding ceases during the day, and later, with the change of coloration, they change their position on the food-plant, descending closer to the ground, on the stem of the banana plant or the leaf bases of the sugar-cane, where their colour again harmonises with their surroundings and they are rendered inconspicuous.

In the laboratory the adults emerged late in the morning; in one instance the actual time of emergence was observed to be 11.20 a.m. The adult is usually seen on the wing about dusk, and if disturbed at other times of the day will only fly a short distance, at once seeking a shady spot to settle. The flight is slow and deliberate, and usually only three or four feet above the ground. When at rest the adult is itself somewhat difficult to discern, for in spite of the two large eye-spots on the underside of its wings its coloration is decidedly protective. The difficulty of detecting the adult after it has come to rest is probably increased by the fact that when the insect is in flight the blue coloration of the upper surface is plainly visible, but with the closing of the wings this colour suddenly disappears leaving one somewhat at a loss as to what to look for, and thus accentuating the already protective coloration.

Larval Scent-Gland.

The larvae possess just in front of the first pair of thoracic legs an eversible scent-gland, which they are capable of extending when disturbed. This gland is ox-blood red in colour. The odour given off by the gland is faint but distinct, and somewhat like that of a goat.

While numerous examples are on record of such glands in lepidopterous larvae no mention of their occurrence in the genus *Caligo* can be found in the literature at my disposal, although Packard states that bladder-like sacs occur in the larvae of many NYMPHALIDAE and other butterflies.

Ackowledgement.

In conclusion I take this opportunity of thanking Mr. W. J. Kaye, F.E.S., for his help in preparing this paper, and for the determination of the adults; it is on his authority that I use the name given here.

Explanation of Plates LXXXI–LXXXIII.

Caligo illioneus illioneus.

Plate LXXXI.

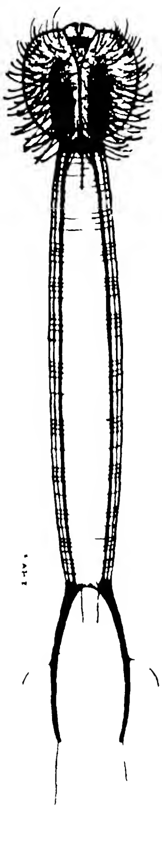
Fig. 1. First instar larva.
2. Second instar larva.
3. Fourth instar larva.

Plate LXXXII.

Fig. 1. Ova.—Parasites have emerged from the two light-coloured ova. The dark one contains dead parasites. Larvae have emerged from the other two and eaten the egg-shells, the remains of which can be seen.
2. Full-grown larva.
3–5. Pupa.

Plate LXXXIII.

(Fig. 6.) Full-grown larvae on banana leaf, showing silk spun on surface of leaf.



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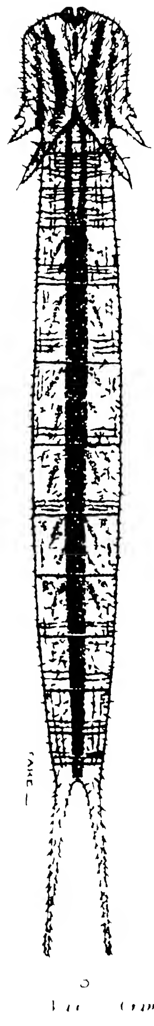

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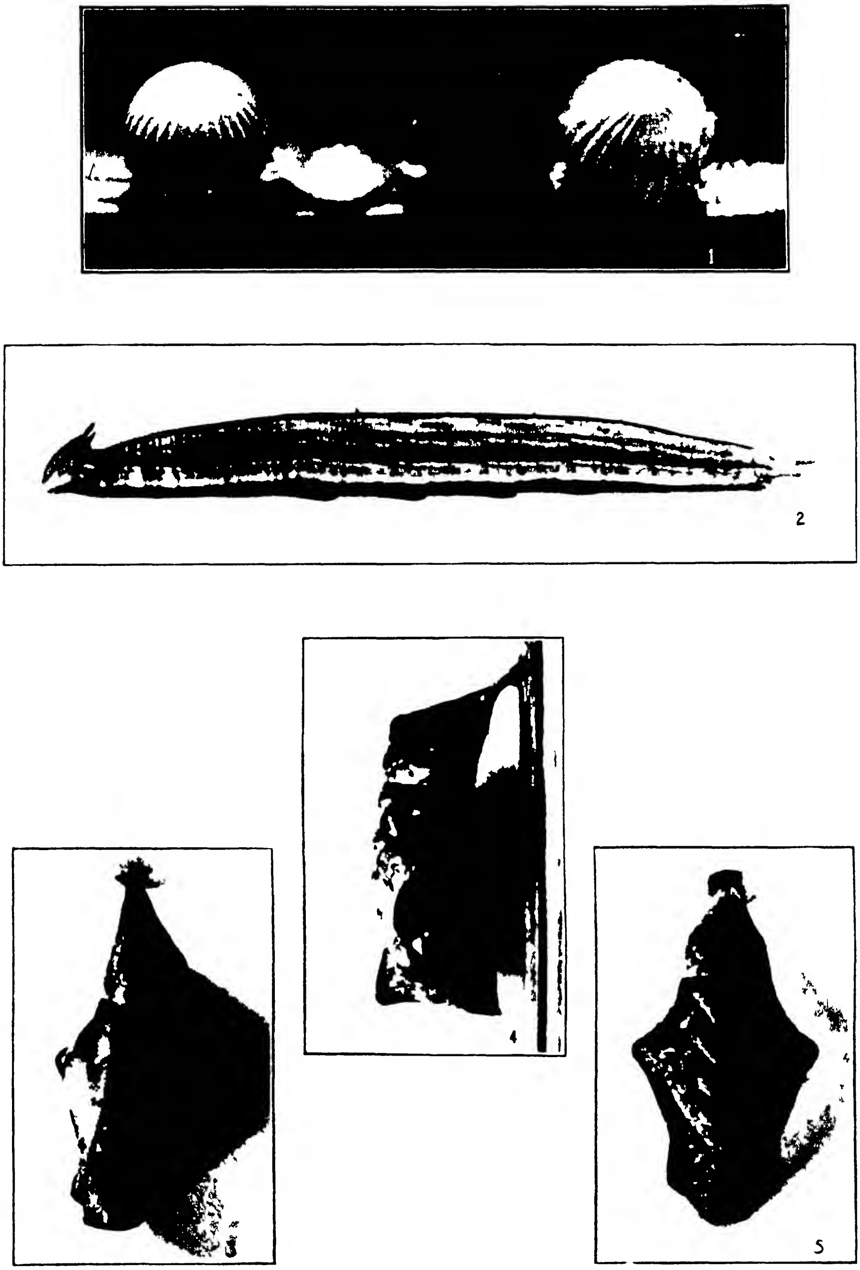
CALIGO ILLIONEUS ILLIONEUS



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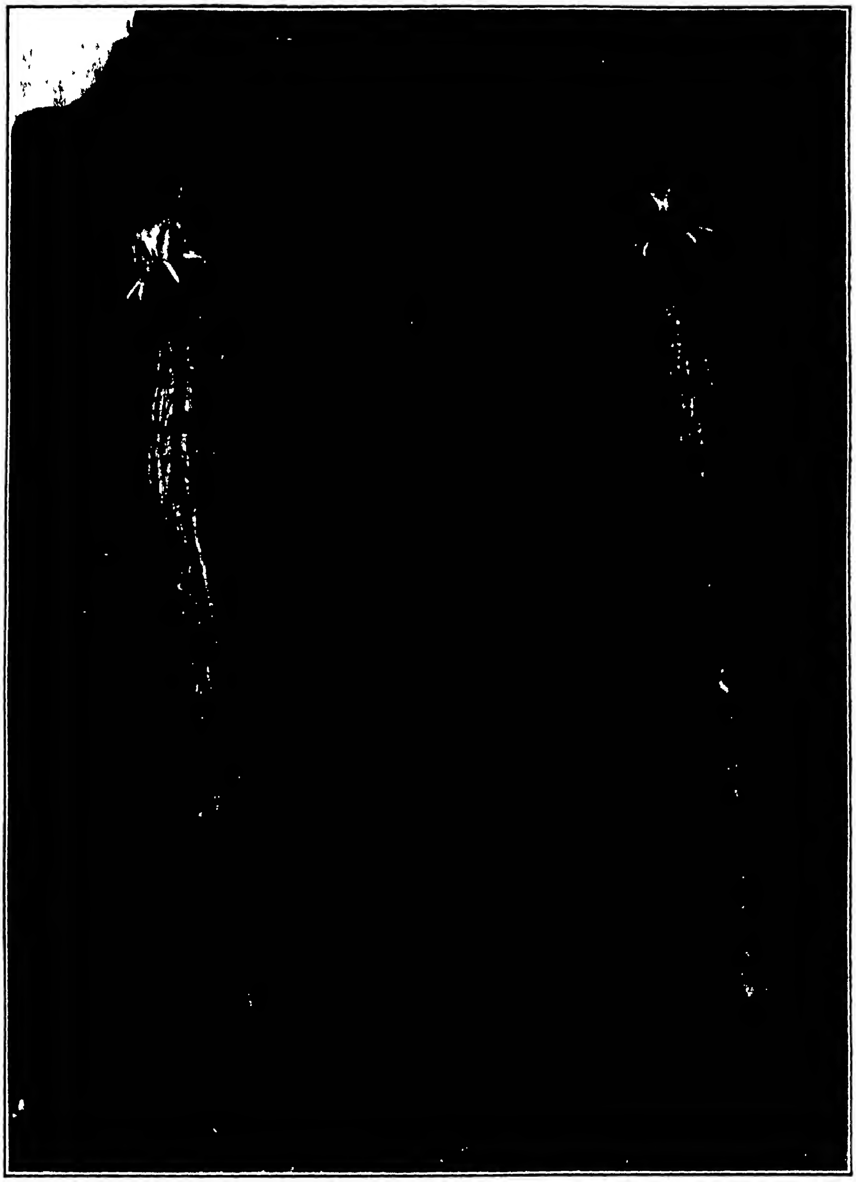


Photo. F. D. Clare Vaus & Crampton Ltd.

CALIGO ILLIONEUS ILLIONEUS

ON A NEW ORGAN IN THE ABDOMEN OF *ERYPHANIS POLYXENA*, MEERB. (LEPIDOPTERA)

By H. ELTRINGHAM, M.A., D.Sc., F.Z.S.

[Read June 2nd, 1926.]

PLATE LXXXIV.

A SHORT time ago my friend Dr. C. L. Withycombe, now of the Department of Zoology, Cambridge, forwarded for my examination the abdomen of a male example of *Eryphanis polyxena* (BRASSOLIDAE) with the information that he had observed, when the insect was in the killing bottle, " two elliptical yellow spots, margined with dark brown, one on either side of the abdomen."

The abdomen had been suitably preserved, so that I have been able to make a careful examination and to cut sections of the organ which Dr. Withycombe detected.

The butterfly itself is a large purple-winged insect, having, near the inner angle of the hind-wings, a very conspicuous yellowish-white patch of special scent-scales, resembling outwardly the brands found on the wings of some male Euploeas. The wings had not been suitably preserved and reached me separately in a dried state, so that I am unable to give an account of the histology of these brands. From their respective positions it seems unlikely that the abdominal organs here to be described can have any relation to the special scales on the wings.

Having cut the abdomen in half longitudinally, and cleared away the fat and other tissues, the organ is very easily discernible, even to the unaided eye, lying in a medio-lateral position on the second segment. Lying above it and somewhat posteriorly is a small dark patch which at first sight appears to be in the interior of the body, but on further investigation proves to be placed on the outside of the third segment but covered by a somewhat thickened posterior projection of the chitin of the second segment. This dark patch is in fact a second organ, not visible on a superficial examination. By placing the preparation at this stage in cedar-oil the fat-cells contained in the projecting flap of the second segment become transparent and both organs can be seen somewhat in the manner shown on Plate LXXXIV, fig. 1. The larger and more anteriorly placed organ is about 2·5 mm. long, 1·0 mm. wide, and roughly elliptical. The smaller organ lying in the third segment is rounder and about 1·0 mm. in diameter. I may at once state that except in size, shape, and position I cannot find any essential difference between the two organs in so far as general structure and histology are concerned. The larger or anterior organ is surrounded by a slightly projecting elliptical ridge which surrounds a shallow depression of the body-wall. Its area is covered with small pale-coloured scales and the surrounding ridge is set with long dark scales curving over towards the centre. This organ is quite unprotected by any covering, whereas the smaller but similar organ in the third segment is completely overlaid by the backward extension of the chitin of the second.

A continuous series of sections was made in a vertical plane transverse to the long axis of the body. Plate LXXXIV, fig. 4, shows a section of a part of the larger of the two organs, cutting through four cells and their appendages.

From this we find that the structure consists of a layer of typical glandular cells lying beneath the outer cuticle. From each cell arises a hollow scale communicating with the interior of the cell and outwardly projecting on the external and slightly depressed surface of the organ.

Fig. 5 is a very highly magnified view of a single cell and its adjuncts. From this enlarged view the parts may be thus described. At *s* is one of the smaller or central scales partly cut through, and showing large granules which take a deep stain in haematoxylin, saffranin, eosin, or methyl blue. The stalk of this scale is set in the socket *sk* formed by the cuticle *c*. This stalk has a long extension which dilates at *ex* into a slight expansion with somewhat thicker walls. From this point it continues as a tube *t* which ends in a funnel-shaped orifice, the edges of which are slightly denticulate. In most examples the orifice appears to be plugged by a more or less rounded but sometimes elongate projection *ss*. This projection or pad has been observed in similar situations in glandular structures and has been called a "secretion sieve." Under a very high power it does not, however, show any signs of actual pores which would make such a term appropriate. Many authors in observing scent-organs, including scent-scales or androconia, have been anxious to establish the existence of pores in some part of the excretory portion of these structures. In my own experience such pores are either absent or they are not visible (except in the wing-glands and perhaps some scales of certain Danaine butterflies). Extremely volatile substances may, however, diffuse through thin membranes. The repulsive odours of Heliconine butterflies are produced from glands which I have described in our *Transactions* (1925, p. 269), but, although the club-shaped organ from which these odours are diffused (in the female) is tubular and in direct communication with the large gland in the abdomen, its external extremity does not show any visible pores, and the same remark applies to the membranes enclosing the great harpal glands of the males of these insects.

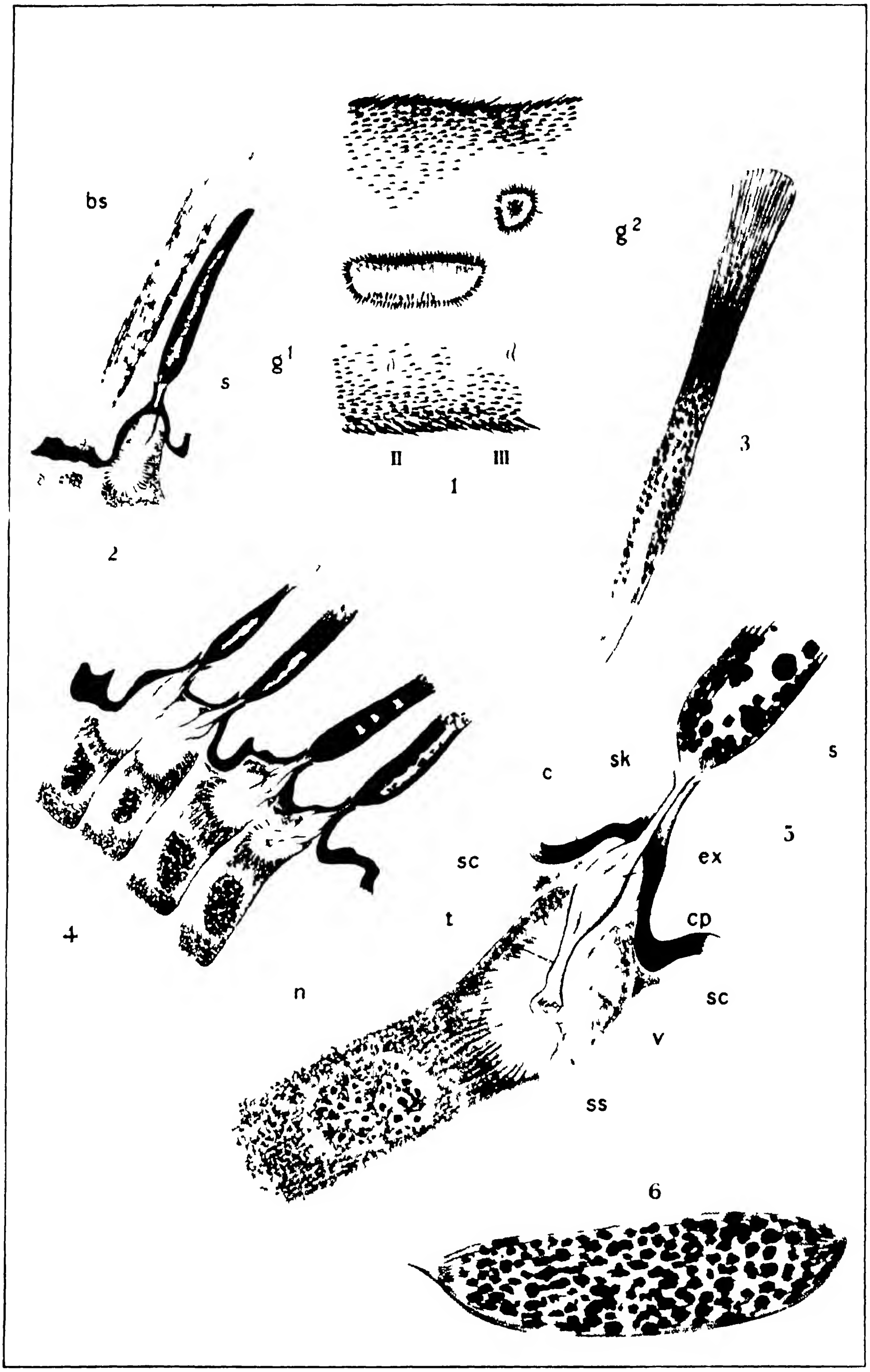
The whole extension of the scale-stalk within the cell lies in a space formed partly by the vacuole *v*, and partly by a somewhat bell-shaped extension of the cuticular chitin *cp*. Round the vacuole the cell-substance presents the radiate appearance often found in active gland-cells, whilst the remaining cytoplasm is uniformly granular and contains a large and conspicuous nucleus *n*. At *sc* are small additional cells which are probably the remaining unmodified hypoderm cells whose function it has been to secrete the cuticle.

Fig. 3 is a drawing of one of the long scales arising from the surrounding edge of the organ, whilst fig. 6 is a much more highly magnified view of one of the smaller scales which arise from the glandular cells.

In sections it is seen that whilst the granules in the smaller scales take a heavy stain those in the large border-cells do not take any stain at all. The large scales arise from ordinary sockets overlying small cells, both sockets and cells devoid of any special structure. The difference between the two kinds of scales is shown at fig. 2, where *s* is the gland-scale and *bs* the border-scale. Probably the granules in the smaller scales are those of the secretion from the large cells beneath, whilst those of the large border-scales are merely pigment.

The same description would apply to the structures seen in sections of either of the two organs, though on the whole the gland-cells of the larger organ (in the second segment) seem rather longer.

We appear therefore to have a pair of actively secreting glands laterally placed on the abdomen, one fully exposed, the other concealed and protected by a posterior projection of the lateral cuticle. Both glands seem to have the



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A NEW ORGAN IN THE ABDOMEN OF ERYPHANIS POLYXENA

same structure, and presumably the same function, so that the presence of two such organs would appear to be in the nature of segmental reduplication. As to their function, much depends on whether they are to be found in the female as well as in the male. The specimen here described is a male. The structure of the glands somewhat resembles that found in *Belostoma americana*, a large aquatic Hemipteron, and in this insect the function is considered to be the secretion of a repulsive fluid. If the glands here described are also present in the female butterfly then we may safely assume their repugnatorial function. If they are purely a male characteristic they must be supposed to be sexual. The butterfly has, however, large scent-patches on the hind-wings of the male and these are not in a position to act in conjunction with the abdominal glands, as for instance in the joint action of the wing-glands and abdominal brushes of Danaine butterflies. In the case of *Heliconius* we know that there are scent-scales on the wings of the males only and these are assumed to be sexual in function, whilst the repugnatorial glands are found in both sexes although not in the same position.

At the moment of writing my friend Dr. C. L. Withycombe, to whom I am so greatly indebted for the material for this research, is endeavouring to obtain a female *Eryphanis* for examination, and also to detect if possible the odour produced by the glands here described.*

Explanation of Plate LXXXIV.

Fig. 1. The second and part of the third segment of the abdomen of *Eryphanis polyxena* after partial removal of the scales, followed by clearing in cedar-oil. g^1, g^2, the glands. g^2, is covered by a posterior projection of the chitin of the second segment.

2. Section showing the different appearances under staining of a gland- and a border-scale. *bs*, border-scale. *s*, gland-scale.

3. A border-scale much magnified.

4. Section through four cells of the gland.

5. A single gland-cell and part of its scale highly magnified. *s*, part of scale. *sk*, socket in external chitin. *c*, cuticle. *cp*, extension of cuticle. *ex*, expansion of scale-stalk. *sc*, *sc*, remains of hypoderm cells. *v*, vacuole. *t*, tube of scale stalk *ss* "secretory sieve" *n*, nucleus.

6. One of the scales of the gland highly magnified

Length of gland-cells about ·078 mm.
,, gland-scales ,, ·01 mm.

* Since the above was written Dr. Withycombe has returned to England, but was unable, before his departure from Trinidad, to obtain any further examples of this butterfly.

THE UNCUS IN THE MICROPTERYGOIDEA (LEPIDOPTERA)

By Alfred Philpott.
(Hon. Research Student in Lepidoptera, Cawthron Institute, Nelson, N.Z.)

[Read October 6th, 1926.]

Plates LXXXV–LXXXVI.

The term uncus, as ordinarily used, is applied to the distal dorsal projection of the terminal (apparent) tergite of the abdomen. Whether this terminal tergite represents the ninth or the tenth tergite is, however, a question not definitely settled. There is practically no difference of opinion as to the vinculum being the modified ninth sternite, but the fate of the upper half of the ninth somite still remains in doubt. The difficulty arises chiefly from the fact that while, in most instances, the supposed lower and upper halves of the somite articulate in the median line (represented by the pleurite under normal conditions), in others the lower portion (vinculum) forms a complete ring round the abdomen, the upper half (tegumen) being attached distally to its apical area, thus appearing as a succeeding somite, or part of one. If, in these latter instances, we take the vinculum and tegumen to be composed of separate somites, we must conclude either that the vinculum includes the ninth sternite and tergite, or that the ninth tergite has been eliminated, the sternite filling its place by the extension of its own lateral pieces until they met and fused on the median dorsal line. The total disappearance of a tergite need not be regarded as improbable, as a sternite (the eighth) has undoubtedly disappeared in many of the Micropterygidae; a displacement of the parts, however, seems to offer an easier explanation. There is also the suggestion that the tegumen is composed of the ninth and tenth tergites. Eyer (3), in a recent publication, treats the uncus as being a part of the anal armature belonging to the tenth tergite, which has become superficially attached to the ninth. This idea of attachment seems to be in the minds of the majority of those who have given some study to the genitalia of the Lepidoptera; that is to say, they regard the uncus as an appendage rather than a process. Pierce (8) speaks of the uncus as being " attached to the dorsal portion of the tegumen " and many of his figures exhibit, perhaps unintentionally, a suture or line of attachment. Busck and Heinrich (2) consider the uncus to be part of the tenth segment, but they include the whole of the tegumen as belonging to that segment, the ninth tergite " being greatly reduced and continued dorsally as membrane only." Bethune-Baker (1) says that the ninth segment in the Micropterygidae has " lost the division between tergite and sternite, and become in *Eriocrania* a broad solid collar," also that " the tenth segment is confined to the sternite area." Macgillivray (5) treats the tegumen as the tenth segment, and the uncus as " the distal end of this structure." Forbes (4) holds the tegumen to be the ninth tergite and the uncus the " dorsal part " of the tenth segment. He adds that in some forms it is " indistinguishably fused with the tegumen." Returning to Eyer (3), we find that, following Zander, he says of the uncus, " this and the following two parts (socii and gnathos) belong to the tenth somite; because of its retraction, however, they

assume a superficial attachment to the tegumen." The tegumen is described as the tergal portion of the ninth somite; the position arrived at therefore differs from that of Busck and Heinrich in that the tenth tergite, not the ninth, is regarded as having become largely membranous. According to Dr. Eyer, Zander and Cholodkovsky (whose articles have not been available to the writer) have described the tenth tergite, in the MICROPTERYGIDAE and ADELIDAE, as "a small terminal sclerite separated from the ninth by a distinct suture." The presence of a suture between the sclerite bearing the uncus and the ninth sternite (whether the latter forms a chitinised abdominal cylinder or is only ventral in position) is normal in the Lepidoptera, but the statement referred to may apply to some structural point not observed by the present writer.

It is proposed now to discuss the condition of the uncus in all species of the MICROPTERYGOIDEA available for examination, with a view to throwing light on the origin of the organ in the most primitive of the Lepidoptera. The vinculum and tegumen as a whole will also necessarily come into the investigation.

MICROPTERYGIDAE.

Sabatinca.

Throughout this genus the ninth sternite (vinculum) has undergone comparatively little alteration compared with that which has taken place in connection with the same sclerite in other groups of the Order. The sternite is still broad, both ventrally and laterally, and is not telescoped within the preceding segment. The most noticeable modification is the enlargement of the ventral anterior area, the space normally occupied by the eighth sternite being taken up by this expansion. This absence of the eighth sternite is to be explained either by the fusion of the two sternites or by the complete dechitinisation of the eighth. The latter is the more probable explanation, as in the related genus *Micropteryx* the eighth sternite is represented only by a narrow strip of chitin. Dorsally the condition of the ninth sternite varies considerably in the different species. The margins may be straight longitudinally, as in the preceding sternites, and with the ninth tergite separated by a normal pleural region (fig. 1, Plate LXXXV); or they may be continued upwards till they meet and fuse on the median dorsal line, thus forming a solid band of chitin round the abdomen, the ninth tergite being apparently pushed into a caudal position (fig. 2). Between these two positions there is an almost perfect series of gradations (figs. 3 to 8, Plate LXXXV), and it becomes necessary to endeavour to decide which is the more primitive structure. I have pointed out elsewhere (6) that the species of *Sabatinca* fall into three groups according to the condition of R^1 in the hind-wing. It will be found that almost the same grouping can be maintained on the condition of the tegumen and vinculum, though the largest group falls into several sections. The most primitive group may be taken to be that in which the first radius is present in its entirety. This includes *S. lucilia*, Clarke, and *S. calliarcha*, Meyr. Here the vinculum encircles the abdomen. In *lucilia* (fig. 8) the distal upper angles meet but do not fuse, while in *calliarcha* (fig. 2) fusion has taken place to a large extent, a broad band across the dorsal region of the abdomen resulting. Turning to the group with the most specialised venation, R^1 of the hind-wing having completely disappeared, we find in *S. zonodoxa*, Meyr., and *S. rosicoma*, Meyr., the least upward extension of the ninth sternite, with

the tegumen in a dorsal, not distal, position to it. In *S. calliplaca*, Meyr., the ninth sternite is considerably extended upwards, but the tergite is still more dorsal than distal to it. Leaving aside for the moment the intermediate group in which R^1 is represented by the vestige known as the "recurrent vein," we seem driven to conclude that in *Sabatinca* the oldest form of the ninth sternite is that of an encircling band, the corresponding tergite having been pushed into a distal position, notwithstanding that the condition as seen in *zonodoxa* and its allies has closer resemblance to an unaltered sternite. On this view the gradations between the two (as seen in figs. 3 to 8) must be regarded as stages in the processes of reduction from the "ring" condition, and not as developments towards it.* On the view that this chitinised cylinder is made up of both sternite and tergite of the tenth somite, it is difficult to explain the complete absence of all trace of a pleural region or of a suture, while on the theory of its sternal nature only the conjunctiva is seen to be merely shifted from a horizontal position to a more vertical one. For the purposes of this paper therefore, it is proposed to regard the vinculum as being composed of the ninth sternite and the tegumen as being made up of the ninth tergite.

Coming now to the tegumen, we find in *Sabatinca* no sign of its composite character. The uncus may be present or not present; or there may be a deep indentation on the area of the margin which it should occupy. This latter condition is particularly marked in *calliarcha* (fig. 11, Plate LXXXVI) and *lucilia*, and is present in a slight degree in *eodora* (fig. 12). There follow such forms as *chrysargyra*, Meyr. (fig. 13), and *aurantiaca*, Philp., in which the distal margin of the tegumen is more or less straight, these leading to those in which it is rounded or pointed, as *barbarica*, Philp., and *aemula*, Philp. (fig. 14). The pointed apex of *aemula* is succeeded by a series of forms in which gradual elongation and narrowing takes place (figs. 15 to 18). In no instance is there any indentation or indication of a suture at the base of the uncus, and there can hardly be a doubt that in this, the most primitive of the lepidopterous genera, the structure is simply a process of the tegumen proper and not an appendage of that or any other tergite.

Epimartyria.

This genus, as far as I have been able to examine the species, agrees closely, in regard to the form of the ninth somite, with the *calliarcha* section of *Sabatinca*. There is the same encircling sternite and short broad tergite with deeply emarginate caudal margin placed distally to it (figs. 19 and 20).

Micropteryx.

In *Micropteryx* the ninth somite has the sternite and tergite fused into a single piece without any suture to indicate the original pleural region. In most species, however, there are indentations on one or both margins, which probably indicate the line of fusion. The uncus may be a slight process, as in *thunbergella*, Fabr. (fig. 22), or may be produced into the elongate organ of *aruncella*, Scop. (fig. 23). The peculiar lateral extensions (surgonopods or surstyli) of the tegumen, present in each of the four species examined, seem to be true extensions of the sclerite and not in the nature of appendages.

* It should be noted, however, that one species of this intermediate group, *S. eodora*, Meyr., still retains the "ring" formation.

ERIOCRANIIDAE.

In this family the ninth somite of the abdomen forms a broad strongly chitinised encircling band. This would appear to be composed of the ninth sternite, the corresponding tergite assuming a distal position. In many species, however, complete fusion has taken place, there being no suture between sternite and tergite (fig. 24). There are, however, frequently deep indentations at the apparent base of the tegumen laterally, and in at least one species, *Mnemonica unimaculella*, Zett. (fig. 25), an obvious suture persists. Here again the caudal margin of the sclerite is emarginate or indented, precluding the presence of an uncus. Where such an indentation is deep the sclerite is divided into two lobes, usually provided with an armature of spines or hairs beneath (fig. 26). In *M. fastuosella*, Zett. (fig. 27), where the indentation is not deep, the lobed effect is still present, the dorsal area having become membranous. *Eriocrania* agrees with *Micropteryx* in the main features.

MNESARCHAEIDAE.

In the MNESARCHAEIDAE the tegumen has been subjected to extreme modification, such modification not following the same plan in the different species. In *Mnesarchaea hamadelpha*, Meyr., *M. similis*, Philp., and *M. loxoscia*, Meyr., the part is represented by a pair of weakly chitinised lobes, the apices of which are rather hairy (fig. 28). Very probably these lobes are the homologues of those referred to above as occurring in certain of the ERIOCRANIIDAE. The three remaining species, *M. parasosma*, Meyr., *M. fusca*, Philp., and *M. fallax*, Philp., need not here be dealt with. The tegumen in these forms is so extraordinarily modified and so different from that of the group already referred to, as well as from that of each other, that the homologues of the parts cannot be definitely ascertained. They have been described and figured in an article (7) to be published in vol. 57 of the *Transactions of the New Zealand Institute*.

CONCLUSION.

With the exception of *Sabatinca* and *Mnesarchaea* it will be seen that the writer has not had full material of any of the genera dealt with. It seems hardly likely, however, that the examination of further species would reverse the general conclusions arrived at, which may be briefly stated to be that the vinculum, whether ventral only or forming a chitinous cylinder, is derived from the ninth sternite, that the tegumen is formed from the ninth tergite, and that the uncus is an outgrowth of that tergite.

For British and European material of *Micropteryx*, *Eriocrania* and *Mnemonica* I am indebted to Mr. O. W. Richards of London, and Dr. Martin Hering of Berlin; I offer sincere thanks to these gentlemen for their valuable assistance.

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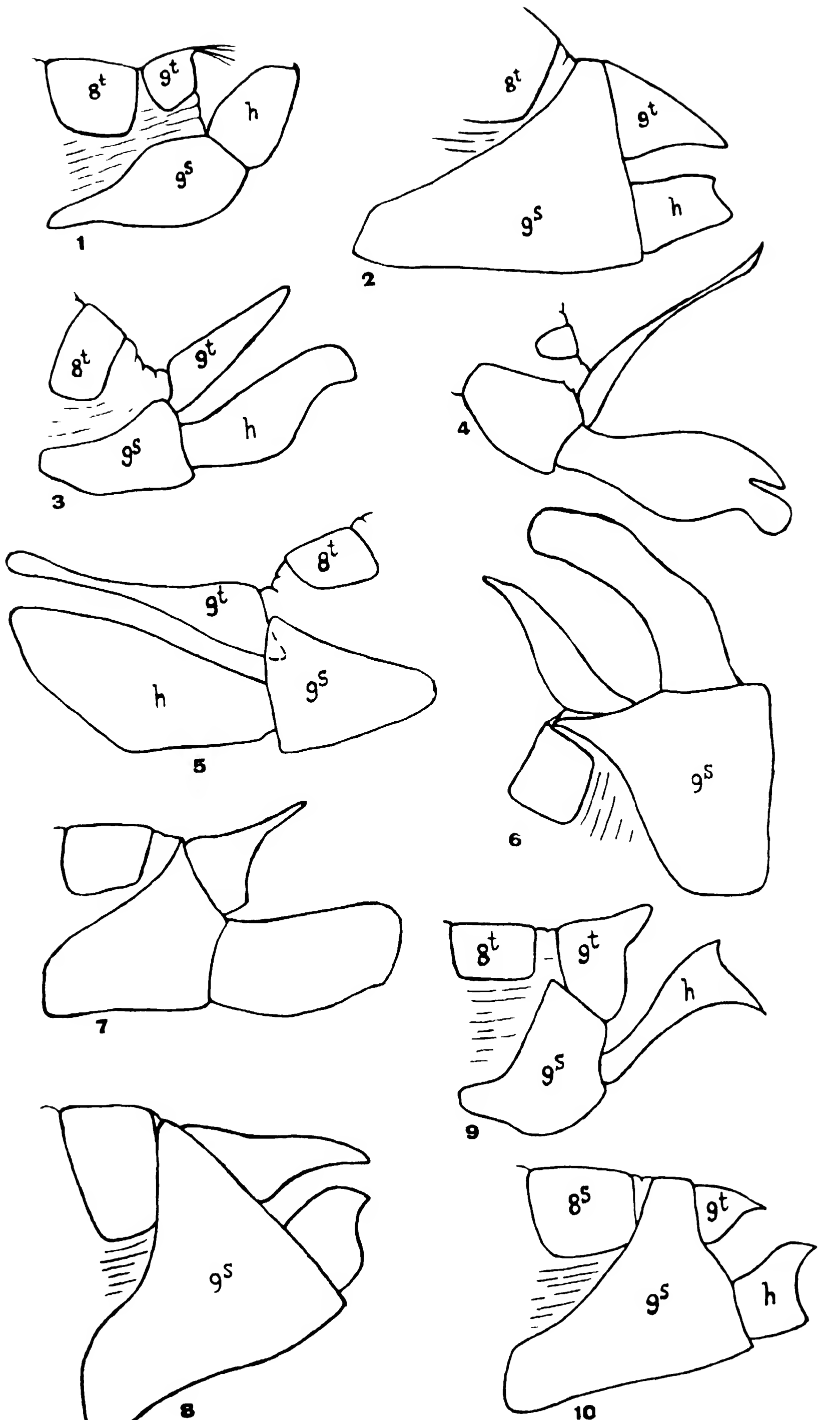

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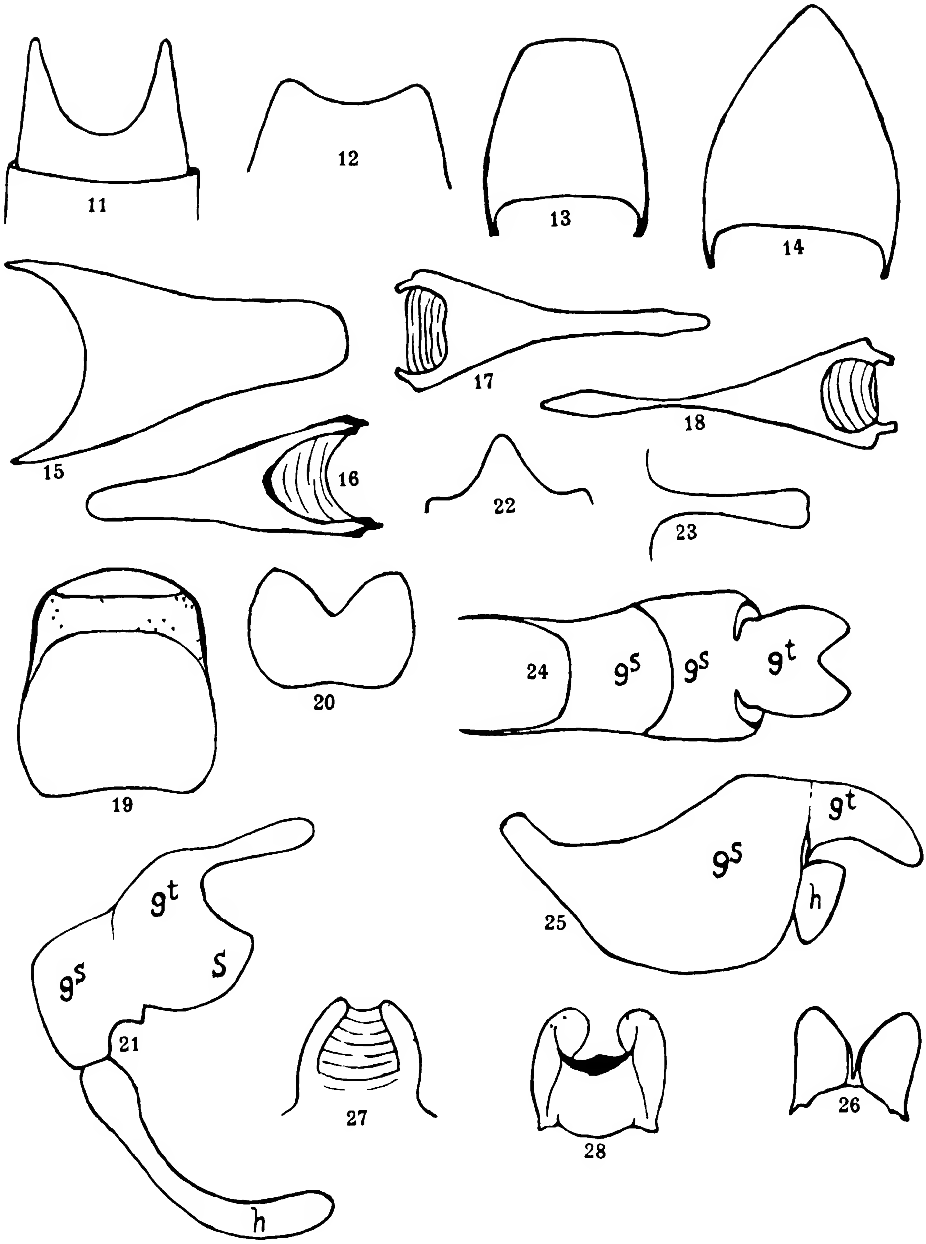

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EXPLANATION OF PLATES LXXXV–LXXXVI.

(The figures have been drawn, after maceration of the material in a solution of KOH, with the aid of a *camera lucida*, and, to avoid distortion, before mounting. For the sake of clearness all armature, such as scales, hairs and spines, has been omitted.)

Lettering.

8^t, 9^s, 9^t = eighth tergite, ninth sternite and ninth tergite respectively. *s.* = surgonopod (lateral extension of ninth tergite). *h.* = harpe.

PLATE LXXXV.

♂. Genitalia; lateral views.

FIG. 1. *Sabatinca zonodoxa*, Meyr.
2. „ *calliarcha*, Meyr.
3. „ *chrysargyra*, Meyr.
4. „ *aurella*, Huds.
5. „ *aenea*, Huds.
6. „ *quadrijuga*, Meyr.
7. „ *barbarica*, Philp.
8. „ *lucilia*, Clarke.
9. „ *calliplaca*, Meyr.
10. „ *eodora*, Meyr.

PLATE LXXXVI.

11. *Sabatinca calliarcha*, Meyr. Dorsal view of tegumen.
12. „ *eodora*, Meyr. Dorsal view of tegumen.
13. *chrysargyra*, Meyr. Dorsal view of tegumen.
14. *aemula*, Philp. Dorsal view of tegumen.
15. *aenea*, Huds. Dorsal view of tegumen.
16. *ianthina*, Philp. Dorsal of view tegumen.
17. *aurella*, Huds. Dorsal view of tegumen.
18. *doroxena*, Meyr. Dorsal view of tegumen.
19. *Epimartyria auricrinella*, Wlshm. Dorsal view of vinculum.
20. „ *auricrinella*, Wlshm. Dorsal view of tegumen.

FIG. 21. *Micropteryx anderschella*, Hübn. Lateral view of genitalia.
22. ,, *thunbergella*, Fabr. Dorsal view of tegumen.
23. ,, *aruncella*, Scop. Dorsal view of tegumen.
24. *Mnemonica auricyanea*, Wlshm. Dorsal view of tegumen.
25. ,, *unimaculella*, Zett. Lateral view of genitalia.
26. ,, ,, ,, Dorsal view of tegumen.
27. ,, *fastuosella*, Zett. Dorsal view of tegumen.
28. *Mnesarchaea loxoscia*, Meyr. Ventral view of tegumen.

THE MORPHOLOGY OF THE AEDEAGUS IN DELPHACIDAE (HOMOPTERA)

By F. Muir.

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[Read October 6th, 1926.]

Plates LXXXVII–LXXXVIII.

The morphology of the male genitalia in the Homoptera has been dealt with by several authors during the last few years. The writer has used them extensively for systematic purposes, especially in the Fulgoroidea. The most extensive work on this subject is by Dr. Hem Singh-Pruthi,* whose paper deals with both the Heteroptera and Homoptera.

In spite of all this work there is quite a number of morphological problems that await elucidation. The present paper discusses some of these in the family Delphacidae.

1. **Asiraca clavicornis** (Fabr.). (Figs. 1–3.)

The aedeagus consists of a small, funnel-shape penis (*p.*) and a large periandrium (*pa.*). The inner wall of the penis is covered with small chitinous spines or scales; the apex of the periandrium bears long, curved spines. The apical portion of the periandrium is narrow, subtubular and slightly curved, the basal portion is much larger and flattened horizontally; the base is produced towards the anal segment as a large plate (the aedeagus basal support, *aed.b.st.*). The inner wall of the penis is continued through the periandrium as a strong, thick, chitinous tube, narrow at apex and gradually enlarging. This is Singh-Pruthi's sheath (*sh.*). As it passes out of the basal foramen of the periandrium (*bf.*) it enlarges into a chamber (*ch.*) which expands basally into a large shield-like body, the basal-plate bridge (*bp.br.*) and wings (*w.*). The dorsal wall of the chamber is membraneous and a band of membrane passes across the middle of the ventral wall, thus making a membraneous hinge which allows the aedeagus and sheath to move in a vertical direction. The sheath is thickest where it joins the chamber. A small sclerite near the base of the genital styles (basal plate) gives rise to a large apodeme (basal-plate prolongation, *bp.pr.*) which forms, or amalgamates with, the chamber to make the bridge (*bp.br.*). The ejaculatory duct (*ejd.*) enters the bridge near the basal-plate prolongation.

2. **Copicerus irroratus,** Swartz.

The aedeagus in this species is similar to that of *Asiraca* in its general plan but the details are distinct.

3. **Stenocranus agamopsyche,** Kirkaldy. (Figs. 4–7.)

In this species the periandrium is large, broad and flattened; the sheath is a long, thick-walled tube, slender until it passes through the basal foramen of the periandrium when it expands out into a large chamber, the dorsal wall and a transverse strip on the ventral wall being membraneous; the chamber expands into a large shield or wing-like bridge; the basal-plate prolongation is large and meets the ventral wall of the chamber in the same manner as in *Asiraca*.

* *Trans. Ent. Soc. Lond.*, 1925, pp. 127–267, figs. 1–280.

4. **Columbisoga taiwanensis,** Muir. (Fig. 8.)

The periandrium is broad at the base, laterally flattened and narrowed and curved to the apex; a curved spine arises near the apex and a shorter one projects at right angles near the base of the curved spine. There is no chitinised sheath, the ejaculatory duct is difficult to recognise in the apical portion of the periandrium, but in the basal half it is recognisable. The chamber is long, the apical portion firmly fastened to the dorsal or posterior margin of the base of the periandrium, the dorsal wall is membraneous and a narrow hinge of membrane crosses the ventral wall. The bridge is well developed and the basal-plate prolongation is large.

5. **Ilburnia blackburni,** Muir. (Figs. 9, 10.)

In this species there is no sheath; the chamber is mostly membraneous with a strong and broad ring of chitin (fig. 9, *cr.*), which is soldered to the dorsal or posterior margin of the base of the periandrium. The bridge and its wing-like expansions are large and the basal-plate prolongation is strong and well developed.

6. **Ilburnia halia,** Kirk. (Figs. 11, 12.)

The aedeagus' basal support forms a ring round the base of the periandrium. There is no sheath, but the membraneous ejaculatory duct can be traced from apex to base. The chamber is similar to that in *Ilburnia blackburni*, but the chitin ring is broader and touches the head of the basal-plate prolongation. The bridge with its expanded wings is typical.

7. **Perkinsiella graminicida,** Kirk. (Fig. 13.)

There is no sheath. The chamber is short and the apex of the broad basal-plate prolongation is soldered to the ventral or anterior margin of the base of the periandrium.

8. **Delphacodes neopropinqua,** Muir. (Figs. 14, 15.)

There is no sheath running through the periandrium. The chamber is similar to that in *Ilburnia halia*, but the chitin ring is not so strong; the wings of the bridge are large.

9. **Saccharosydne,** Kirk, and **Neomalaxa,** Muir. (Figs. 16–18.)

The genera *Saccharosydne*, Kirk, and *Neomalaxa*, Muir (Figs. 16–18), depart from the normal type more than any so far described. The periandrium is of extreme length and thinness with thin walls; a sheath with thick, flexible, translucent walls passes from end to end. This long, slender aedeagus when at rest lies coiled up in a large invagination (*gi.*). In a former description of this insect the writer stated that there was practically no aedeagus but that there was a long, slender, coiled internal structure of unknown use. This mistake was made on account of the very slender walls of the invagination and its large muscular covering. Only having old, cabinet specimens for examination, it was difficult to clear the tissues away without breaking the walls. In *Saccharosydne saccharivora* (Westw.) the aedeagus has a small spine at the base of the periandrium (Fig. 18), which was considered as the aedeagus. The chamber is long, the apex of the basal-plate prolongation forming its ventral wall; the wings of the bridge are large. In *Neomalaxa flava*, Muir (Figs. 16 and 17), the basal-plate prolongation and the chamber form a curve, but the general structure is similar to that of *Saccharosydne*.

In the ten species mentioned above we have very different types of aedeagus. How far these types will cover the whole family it is not possible to say, but

the writer has dissected about three hundred species of DELPHACIDAE and so far they are modifications of the types described above.

In the interpretation of the morphology there is room for considerable differences of opinion. Dr. Singh-Pruthi considers the basal plate (or plates), the basal-plate prolongation, the bridge and its wings, the chamber and the sheath as one morphological unit, and he states that the ejaculatory duct passes through the bridge, chamber and sheath till it enters the vesica (penis). If this interpretation could be demonstrated it would be of great interest, for nowhere else in insect morphology does an apodeme form such complex structures. The nearest approach would be the tentorium of the head, which is formed by three pairs of apodemes or invaginations. Unfortunately Dr. Singh-Pruthi does not produce any definite evidence to support his view, and only a study of development will definitely settle the question.

The writer cannot accept the above interpretation chiefly because he has been unable to trace the ejaculatory duct through the chamber and the sheath. Many mounted specimens have been examined under high powers (× 1800), some of them stained, but he has failed to trace any signs. His interpretation is that the sheath is the thickened and chitinised ejaculatory duct, and the chamber an enlargement of the ejaculatory duct. The basal-plate prolongation is an apodeme of the basal plate, and the bridge and wings are formed by the soldering together of an expansion of the apex of the basal-plate prolongation and an expansion, flattening out and chitinisation of the chamber or ejaculatory duct.

That the bridge and wings form a composite structure can be seen in many of the specimens examined. In one specimen of *Ilburnia blackburni* it is possible to see an optical section through the middle, and in this it is possible to trace the expansion of the chamber (fig. 10), and the ejaculatory duct as a continuation of the chamber (fig. 10, *ejd.*). In many, if not all DERBIDAE there is no basal plate or prolongation, and the chamber and wings are formed from the ejaculatory duct alone.

Figure 19 represents diagrammatically the arrangement of the structures according to Dr. Singh-Pruthi, and figure 20 the same according to the writer. A study of development may eventually show which of these interpretations is correct.

EXPLANATION OF PLATES LXXXVII–LXXXVIII.

PLATE LXXXVII.

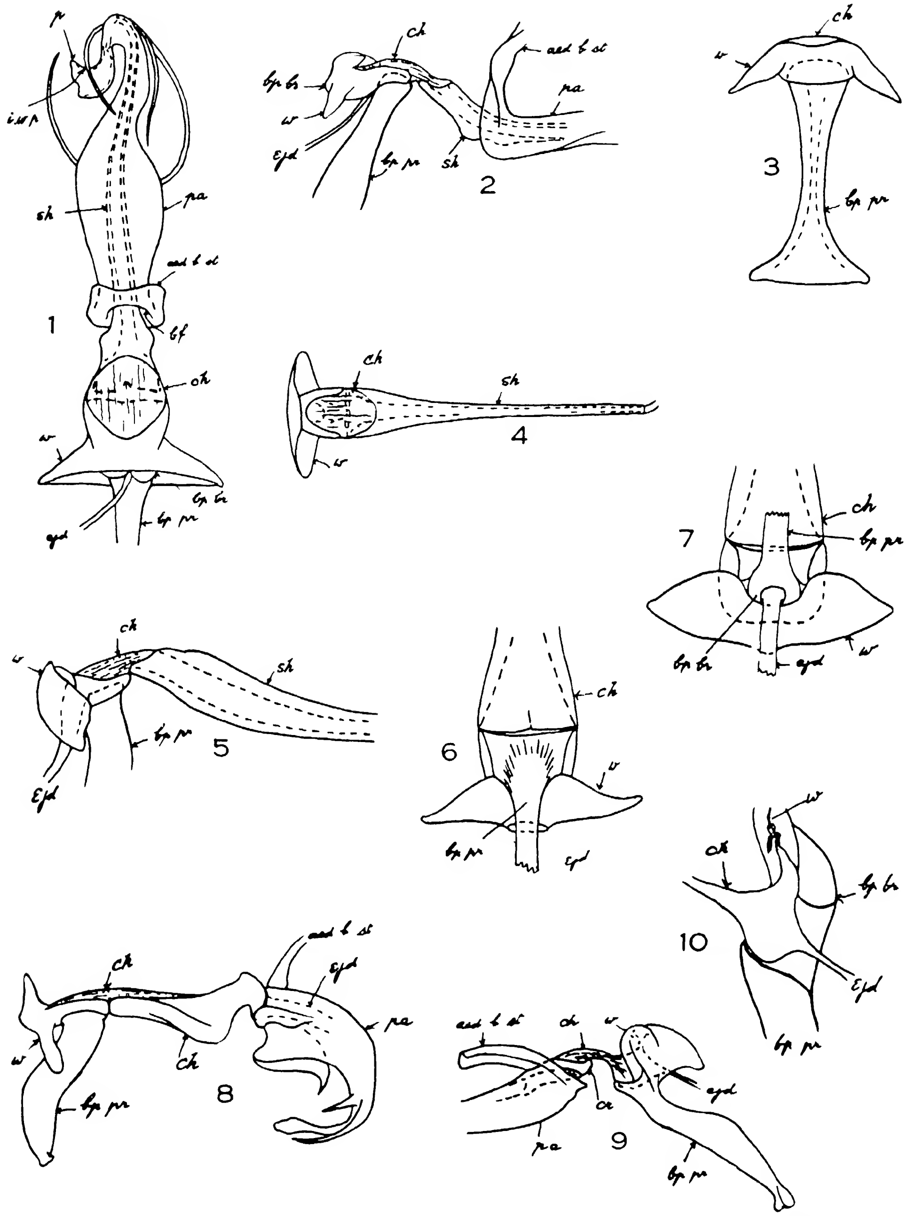
FIG. 1. *Asiraca clavicornis*, dorsal view of aedeagus, chamber and basal-plate prolongation.
2. *Asiraca clavicornis*, lateral view of same.
3. *Asiraca clavicornis*, basal-plate prolongation with chamber and wings.
4. *Stenocranus agamopsyche*, dorsal view of sheath and chamber.
5. *Stenocranus agamopsyche*, lateral view of same.
6. *Stenocranus agamopsyche*, ventral view of chamber and wings.
7. *Stenocranus agamopsyche*, end view of same.
8. *Columbisoga taiwanensis*, lateral view of male aedeagus.
9. *Ilburnia blackburni*, lateral view of base of aedeagus, chamber and basal-plate prolongation.
10. *Ilburnia blackburni*, diagrammatic optical section hrough basal-plate bridge and wings.

Plate LXXXVIII.

Fig. 11. *Ilburnia halia*, lateral view of aedeagus, chamber and basal-plate prolongation, and bridge.
12. *Ilburnia halia*, view of basal-plate bridge and wings.
13. *Perkinsiella graminicida*, lateral view of aedeagus, chamber, wing and basal-plate prolongation.
14. *Delphacodes neopropinqua*, the same as above.
15. *Delphacodes neopropinqua*, view of wings, bridge and basal-plate prolongation.
16. *Neomalaxa flava*, lateral view of male genitalia.
17. *Neomalaxa flava*, lateral view of the basal and apical portion of periandrium, the chamber, wings and basal-plate prolongation.
18. *Saccharosydne saccharivora*, lateral view of base of periandrium, the chamber, wings and basal-plate prolongation.
19. Diagrammatic representation of structure according to Dr. Singh-Pruthi.
20. Diagrammatic representation of structure according to Muir.

Lettering of Figures.

aed.b.st.	aedeagus basal support.	*ejd.*	ejaculatory duct.
as.	anal segment.	*gi.*	genital invagination.
bf.	basal foramen.	*gs.*	genital style.
bp.br.	basal-plate bridge.	*i w.p.*	inner wall of penis.
bp.	basal plate.	*p.*	penis.
bp.pr.	basal-plate prolongation.	*pa.*	periandrium.
br.	bridge.	*pg.*	pygofer.
ch.	chamber.	*sh.*	sheath.
cr.	chitin ring.	*w.*	wing.



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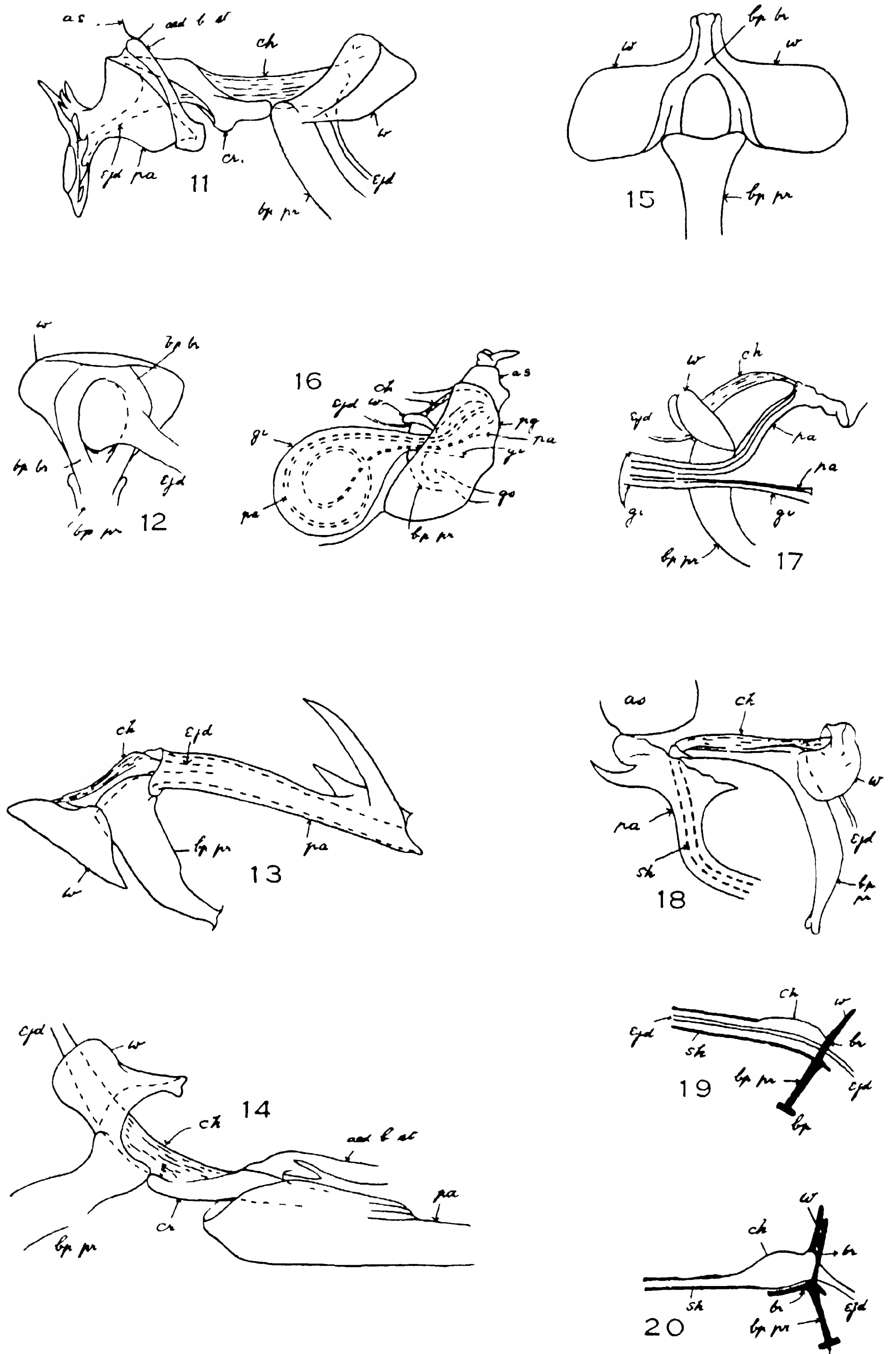
THE AEDEAGUS IN THE DELPHACIDAE



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THE AEDEAGUS IN THE DELPHACIDAE

THE IMMATURE STAGES OF *PSEPHENOIDES GAHANI*, CHAMP. (COLEOPTERA : DRYOPIDAE)

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(Communicated by G. C. Champion, A.L.S., F.Z.S.)

[Read October 6th, 1926.]

Plates LXXXIX–XC.

Mr. G. C. Champion, of Horsell, Woking, Surrey, has kindly given me for study and description many larvae in different stages and several pupae of the Dryopid species *Psephenoides gahani*, Champ. This material was collected by his eldest son, Mr. H. G. Champion, in the Nandhaur River, Haldwani Division, Northern India, in 1924. It is preserved in alcohol and is in good condition. Through the courtesy of Mr. Champion the U.S. National Museum has been able to avail itself of a representative collection of all stages. The main material is in his possession.

The Larvae.

According to their size the larvae in the material can be separated into three groups, namely, one including specimens measuring about 1·5 mm., one with specimens of about 2·5 mm., and a third in which the larvae vary from 3 to 4 mm. This third group unquestionably consists of the mature larvae, as in most of them the pupa is visible below the larval skin. Of these mature larvae the smaller specimens measuring 3 mm. may be male larvae and the larger measuring 4 mm. are female larvae. The larvae of 1·5 mm. seem too large to be first instars but are possibly second instars, in which case the species will have four larval stages.

The shape and proportions of the whole body and of the single anatomical structures are identical in all instars * examined, but the colour varies slightly, being generally somewhat lighter in the younger stages *; however, both light and dark coloured specimens are found in all stages. It will only be necessary to describe an instar of one of the stages, and naturally a mature larva is selected on account of its larger dimensions.

Mature Larva.

(Material in U.S. National Museum, consisting of (*a*) one vial, marked: "*Psephenoides gahani*, Champ., Nandhaur Riv., Haldwani Div., India. 20.v.1924. H. G. Champion coll.; A. G. Böving's drawings and description made from the present specimen"; (*b*) one vial with three larvae of different sizes, from same locality as the type specimen; (*c*) five slides with anatomical details; (*d*) one mature and two immature larvae placed dry in collection of imagines.)

The body is scale-like, broadly oval, with the combined thoracic and combined abdominal segments about equal in size, forming two almost symmetrical halves; urogomphi (= cerci auct.) absent. The head with its appendices and the widely

* The terms "stage" and "instar" have been applied as suggested by J. W. Folsom in his manual, 1913, p. 128, the first term meaning the intervals between the moults and the second term the insect itself at any particular stage.

separated legs are concealed below a slightly convex and strongly projecting roof formed by the thoracic and abdominal tergal shields with their lateral and radially extending expansions. These expansions fit closely together except in places not far from the free margins, where fairly large, lanceolate apertures are present between the posterior and anterior margins of two successive segments (figs. 9 and 10, Plate LXXXIX).

The dorsal surface of the larva is darkish in colour with light spots (fig. 12, Plate XC). In a typical abdominal segment a single transverse, somewhat hourglass-shaped white spot is located in the middle of the back; on each side of it are two minor spots with circular outline, and near the free margins is a large subtriangular spot. In the thoracic segments the median spots are much reduced in size, subtriangular in prothorax and divided into two small paramedian circular spots in mesothorax and metathorax; on the other hand, the two pairs of round lateral spots of an abdominal segment have increased in size and joined together into a large whitish ring, and each marginal triangle of the abdominal segments is here split into a pair of twin triangles.

Dorsally and ventrally (figs. 9 and 10) the larva appears glabrous when examined with a hand lens, but under high-power magnification it is seen to be covered with minute round glandular openings and stellate hairs with four radiating rays (fig. 4); however, from the front edges of the oval apertures a short fringe extends backward, and the free edges of the lateral expansions are trimmed with a dense continuous fringe whose single hairs appear to be split diffusely but really are coalescent from basis to tip and also fused with their neighbours. A single seta (or a few simple, long setae) is present in the posterior part of the free edge of each expansion and reaches somewhat beyond the fringe. In each of the posterior corners of the mesothoracic and metathoracic expansions a short fringe is directed obliquely outward and backward.

On the ventral surface (fig. 10, Plate LXXXIX) of the body thin, soft hairs are distributed all over, but well apart and without order, and large ring-shaped, probably glandular sucking disks are found copiously toward the middle, but not on the expansions. These disks are button-like, short-stalked and set in the middle of small cup-shaped warts (figs. 6*a* and 6*b*).

The head is comparatively small, with large, obliquely ventral occipital foramen, capable of protruding vertically from and retracting back into a pocket formed by the prothoracic presternum (*ps.*, fig. 10). In details the single parts of the head are built as follows:—

Frons distinct, triangular and reaching the occipital foramen.

Epicranium with hind margin dorsally transversely straight and latero-ventrally triangularly prolonged (figs. 9 and 10); deep hypostomal emargination (fig. 10) between the mandibular condyle and the articulation of cardo.

Ocelli (fig. 3, Plate LXXXIX) probably six on each side, almost completely fused together into a large, somewhat kidney-shaped, black optical spot; indistinct lenses traceable around the edge of the spot.

Antenna (fig. 2) shorter than the head, about one and one-half times as long as the mandible, three-jointed with a large basal membrane; proximal joint not much longer than wide; second joint about five times longer than basal joint and approximately as long as the external face of the mandible; distal joint (3, fig. 2) with a short terminal seta, small, digitiform, laterally inserted at the end of the second joint along side with a slightly shorter process (*S*, fig. 2) with a chitinous thread inside; end of second joint almost completely capped by a dome-shaped tactile papilla (*D*, fig. 2). Proximal antennal joint with a few sensory punctures, second joint with a minute seta at the end.

Clypeus (fig. 5) large, subtrapezoidal.

Labrum (fig. 5) well developed, transverse subrectangular with rounded antero-lateral corners, along front margin with a series of small cups into each (?) of which a short seta is inserted.

Mandible (figs. 2 and 5) short, not extending beyond epipharynx, subtriangular, almost equilateral with single apex and inner face excavated like a spoon from apex to about the middle; a long plumose seta inserted midway in this cavity and a series of short bristles present along its dorsal edge; no setae on the external face of the mandible; no retinaculum; no molar part and no supplementary ventral condyle.

Ventral mouth-parts deeply retracted. Maxillary articulating area (*maa.*, fig. 1) well developed, present between maxilla and submentum.

Maxilla (fig. 1, Plate LXXXIX) with bipartite, narrow cardo and simple, well-developed stipes; palpiger (*pg.*) large, carrying a rather short, three-jointed palpus; both lacinia and galea present, large and extending forward; top of galea reaching almost to the end of palpus; lacinia (*l.*) lobe-shaped, apically angulate, with a series of slightly curved, short, stiff setae along the inner margin, and thickly covered by fine hairs both on the dorsal and ventral surface; galea (*g.*) rounded and single (not transversely bipartite), almost of the same size as lacinia, and also provided with a marginal series of short spine-like setae and dorsally and ventrally with a dense fur of long thin hairs.

Gula (*gu.*, fig. 1) short, broad, membranous and band-like.

Submentum (*sm.*, fig. 1) large, barrel-shaped in outline, soft and nude, with numerous sensory pores, separated from mentum by a transverse, straight medianly interrupted suture.

Mentum (*m.*, fig. 1) posteriorly as wide as submentum but only half as long, carrying two long setae on each side and a few sensory pores; indistinctly separated from eulabium by suture.

Eulabium (*eli.*, fig. 1) short and wide; labial palpiger rather distinct and almost joint-like; labial palpus with two short but distinct joints; ligula (*li.*, fig. 1) very broad, extending as far forward as the end of the labial palpi, densely setose.

Epipharynx (fig. 5) large, soft, covered with papillose soft processes in the anterior and median region, otherwise mostly naked; two or three peg-like papillae paramedianly on each side; a pair of chitinous epipharyngeal rods present.

Hypopharynx (fig. 7) soft, without hypopharyngeal chitinisations, completely covered with long fine hairs except in a narrow, longitudinal, posteriorly somewhat widened gutter-like region in the slightly raised middle of the organ.

Prothorax (figs. 9 and 10) with large, crescentic, pocket-shaped presternum (*ps.*) in front of the transverse, subrectangular, band-shaped eusternum (*es.*); sternellum small and only indicated. Prothoracic lateral expansions reaching far beyond the head and meeting in the longitudinal middle line along a distinct straight suture; the latter continuing backward over the not expanded part of the prothoracic tergum and the corresponding parts of mesothorax, metathorax and the first seven abdominal segments. Each prothoracic tergal half subtriangular, almost equilateral, with pocket-shaped, setose emargination on the hind margin and carrying in the posterior corner a large curved excretory slit. Each of the mesothoracic and the metathoracic tergal halves subtrapezoidal, with a pocket-shaped naked emargination midway along the anterior edge of the expansions, and opposite, on the posterior edge, a similar but setose emargination.

Hypopleural chitinisations of all thoracic segments present but membranous; prehypopleurum (*ph.*, fig. 10) probably united with a large trochantin and forming together with it an inwardly excavated case or scuttle, supporting the large horizontal coxa; posthypopleurum (*poh.*, fig. 10) small.

First to sixth abdominal segments on each side with a subtrapezoidal expansion, anteriorly and posteriorly emarginate as in mesothorax and metathorax, and also with the posterior emargination setose and the anterior naked, forming together an oval opening.

Seventh abdominal segment (figs. 4, 9, 10) with backward directed, securiform expansions; the anterior emarginations as in the preceding segments, but the posterior

one very large and with a deep pocket enveloping the lateral margins of the ninth segment.

Eighth abdominal segment small, without lateral expansions, dorsally (fig. 9) campanulate, ventrally (fig. 10) transverse, crescentic, with concavity facing backward, the horn-shaped extremities probably corresponding to the lateral expansions of the preceding segments.

Ninth abdominal segment small, dorsally (fig. 9) obcampanulate, almost symmetrical with the corresponding part of eighth segment, and movable up and down; on each side connected by an extensile membrane with a triangular sclerite (fig. 10) homologous with the lateral expansions of other segments. The ventral shield of the same form and size as the dorsal, also movable up and down and likewise connected by extensile membrane with the lateral triangular sclerite.

Tenth abdominal segment soft, mamillate, protruding from the bottom of a pocket-shaped cloaca between the dorsal and ventral elements of the ninth segment and capable of considerable extension and retraction. Anus located in the distal end of the segment, and three tassels of long branchial filaments attached proximally near its beginning.

Legs (figs. 8 and 10, Plate LXXXIX) inserted widely apart, slightly increasing in size from fore to hind, rather long and strong; coxae converging, somewhat longer than the sternal regions of their segments, almost level with the ventral body surface; trochanter free and subclavate, about half as long and wide as coxa; femur boomerang-shaped, not fully as long and wide as coxa; tibia straight, slightly tapering distad, about of the same length and width as trochanter; trochanter, femur and tibia directed outward; claw * strong, short and very curved. Setae of middle size or longer, present in the number of one or a few on all the leg joints; a single, S-shaped seta inserted on the claw, extending nearly to its tip.

Respiratory system. A pair of well-developed main tracheal stems (*Tr. S.*, fig. 9) present, one on each side, extending from the bases of the gills on the last abdominal segment to the head, anastomosing by fine, transverse connecting tubes and distributing a fine tracheal network to the body surfaces and the internal organs.

Spiracles (*sp.*, fig. 9 on fourth abdominal segment) all rudimentary, present on the dorsal side of the body between the emarginations and toward the middle of the lateral expansions, or in the back corners of the eighth abdominal segment. Each spiracle is connected with one of the main tracheal stems by a rudimentary, solid, thread-like spiracular tracheal branch.

Gills (figs. 9, 10 and 11, Plate LXXXIX) grouped in three tassel-like tufts on tenth abdominal segment; retracted into or protruding from the cloaca between the projecting and movable dorsal and ventral shields of the ninth abdominal segment. Each branchial filament containing a single dark trachea with well-developed spiral threads (taenidia) and ramified only at the distal end where it is divided into a new tassel of diminutive branches (indicated on figure 11 by a small arrow).

Habits.—By way of inference from the anatomical characters of the larva it seems possible to form the following general idea about its habits: It is an aquatic and submerged larva which attaches itself firmly to stones, pieces of wood or similar objects in running water. It feeds on Diatomaceae, with which algae or their shells the alimentary tract is filled; oesophagus is completely lined (fig. 5) with a fur of numerous fine processes directed backward, which possibly retains the free-swimming organisms.

Prepupal interval.—In many of the specimens examined of the mature larva the pupa is found almost fully developed inside the larval skin (fig. 13), but the large wingpads of the free pupa are not yet developed, only indicated

* According to different morphological interpretations, considered either a claw-shaped tarsus or a fused tarsus and claw, a "tarsungulus."

and directed straight outward inside the lateral expansions of the mesothorax and metathorax of the larva, and the characteristic long spines and spreading hair tufts of the free pupa are closely appressed to the dorsal surface and directed to the middle of the body in the enclosed pupa. It seems most likely that the pupa makes use of these spines and hairs in extricating itself from the larval exuviae by gradually raising them during the process of ecdysis. The well-developed spiracles of the pupa are seen inside of the larval skin immediately below the rudimentary spiracles of the larva.

Taxonomic comments. The larva of *Psephenoides gahani* represents a genus of the family DRYOPIDAE and is closer to the larva of the genus *Helichus* * than to any other described Dryopid larva. In general habitus the larva of *Psephenoides* is strikingly similar to the larvae of the family PSEPHENIDAE, and only by close examination of the taxonomic characters the following two fundamental differences are to be found between the PSEPHENIDAE and the DRYOPIDAE (including the HELMIDAE): (A) In the PSEPHENIDAE, represented by the larvae of the genera *Psephenus* and *Eubrianax*,† freely exposed gills are present below the first to fifth abdominal segments, but no similar structures occur in the DRYOPIDAE HELMIDAE. (B) No terminal branchial pocket with three feather or tassel-like gills is found in the PSEPHENIDAE, but is always developed in the DRYOPIDAE HELMIDAE.

In the genus *Psephenus* a four-jointed maxillary palpus is present, and no known larvae of the DRYOPIDAE HELMIDAE have more than a three-jointed palpus. However, in all the specimens of *Eubrianax* preserved in the National Museum, the maxillary palpus is mutilated and thus it is impossible at present to know what importance as a family character can be attributed to the number of joints of this mouth-part.

The usual taxonomic arrangement of the family PSEPHENIDAE close to the family DRYOPIDAE HELMIDAE is substantiated by their larvae, but this does not mean that the PSEPHENIDAE can be considered as directly outgrown from the DRYOPIDAE HELMIDAE. The phylogenetic development of the DRYOPIDAE–HELMIDAE is not difficult to follow back to the CHELONARIIDAE (*Chelonarium lecontei*, Thom., reared and preserved in the National Museum), a family hitherto placed in the DASCILLOIDEA, and the larvae of this family can be linked up with the less specialised larvae of the family HETEROCERIDAE, but in some ways it is not easy to connect the PSEPHENIDAE with any of these families, and they may finally have to be traced back to such forms as *Anchytarsus* and *Ptilodactylus*.

THE PUPA.

(Material in U.S. National Museum, consisting of (*a*) one vial, marked: "Two pupae (♂ and ♀) of *Psephenoides gahani*, Champ. Nandhaur Riv., Haldwani Div., India. 20.v.1924. H. G. Champion Coll.; A. G. Böving's drawings and description made from the present specimens"; (*b*) one vial with two pupae, from same locality as the type specimen; (*c*) two slides with microscopical details.)

* The larva of *Helichus lithophilus*, Germ., is figured and compared with that of *Psephenus lecontei* in a paper, "Psephenus lecontei—on the external anatomy of the larva," by D. S. Kellicott, Buffalo, N.Y., published in *The Canadian Entomologist*, vol. 15, 1883, pp. 191–196, one plate.

† *Eubrianax* is customarily placed in the subfamily EUBRIINAE of the superfamily DASCILLOIDEA according to the characters of the imagines, but this arrangement is not correct according to the larva of *Eubrianax*, which in every essential character conforms with that of *Psephenus* (compare Leng, *Cat. Coleopt. of America North of Mexico*, 1920, pp. 32–33 and p. 187, footnote).

The body (figs. 14 and 15, Plate XC) is scale-like, almost circular, 3 to 4 mm. in length; the smaller ones (fig. 14) possibly males, the larger ones (fig. 15) females; the length of the combined thoracic segments is in proportion to the combined abdominal segments about as 1 to 1½. No urogomphi (= cerci auct.). The head with its appendices, the legs and wingpads are concealed below a slightly convex and strongly projecting roof formed by the thoracic and abdominal tergal shields with their lateral, radially extending expansions. These expansions fit closely together along their entire front and hind margins. A dark and well chitinised, transverse, elongate plate-like thickening occupies the greater part of each side of the tergal shields, except on prothorax where they cover only a minor part of the large shield and are arranged parallel with the longitudinal middle line of the body. On prothorax, the two other thoracic segments and the first seven abdominal segments the plates to the right and left are separated by a soft-skinned median interspace almost as wide as the median length of an abdominal segment. The eighth abdominal segment is without lateral tergal expansions, campanulate and completely covered with dark, thick chitin. The ninth abdominal tergite is reversely campanulate but otherwise similar to the eighth in size and chitinisation; together they form an oval plate, which is completely surrounded by the expansions of the seventh abdominal tergite.

The dorsal side of the pupa (fig. 14) is unusually hairy. A median, unpaired patch of rather short setae is found in the interspaces between the dark thickenings; short setae are arranged in a transverse row in the posterior margins of the segments; the free margins of the expansions carry a continuous fringe of small amalgamated hairs; on the second to seventh abdominal segments inside of the anterior and the posterior lateral corners of the expansions short series of moderately long setae extend, correspondingly, obliquely backward and obliquely forward, and on each of the same segments, immediately inside of the anterior row of the corner setae, a very long, stiff and movable spine is found, surrounded by a thick tuft of long soft hairs.

The underside of the body (fig. 15) is soft skinned, pale and almost without hairs.

The head is small, imbedded in a niche in the ventral part of the prothorax. The antennal sheaths are rather thick, hamate and transversely placed; eye-covers large; the hoods of the mouth-parts are all present, directed backward and pressed closely against the sternal wall of prothorax. The wingpads are attached widely apart; those representing the elytra (= alae anteriores) are broad, not much longer than wide, and with their tips reaching only half-way across the second abdominal segment; the pads of the alae (= alae posteriores) are slightly narrower than the elytra, twice as long, posteriorly attenuate and here curved outward, reaching to the fifth abdominal segment.

Leg-sheaths long, inserted well apart; the distal ends of the prothoracic pair reach to the middle of the second abdominal segment, the distal ends of the mesothoracic go to the middle of the third abdominal segment, and the ends of the metathoracic ones to the middle of the fifth abdominal segment; the prothoracic and mesothoracic leg-sheaths are visible in full, the metathoracic completely hidden by the wingpads except for the tips.

Spiracles annular, small, but distinct, dorsal and located at the basis of and exterior to the thick spines of the second to seventh abdominal segments and on a somewhat corresponding place on the eighth abdominal segment.

Gills wanting. The cloaca formed between the dorsal and ventral parts of the ninth segment contains a reduced tenth segment with the genital organs and the anus.

The male pupa (fig. 14) seems to be slightly smaller than the female pupa (fig. 15), but no difference in size and form has been noticed between the antennal sheaths of the two sexes.

Comments.—The pupa of *Psephenoides* is very different from any other

known coleopterous pupa and deviates particularly from that of the PSEPHENIDAE and the known pupae of the DRYOPIDAE. The *Psephenus* pupa is flat, soft, and covered dorsally with the chitinised tergal shields of the last larval instar * and all the DRYOPIDAE pupae preserved in the National Museum are soft, free, and similar to the pupal type commonly found in Coleoptera.

THE IMAGINES.

(Material in U.S. National Museum consisting of (*a*) one vial, marked like those of the larvae and pupa, containing one male and one female, (*b*) three dried specimens of the male and one of the female placed in the collection of imagines.)

Descriptions of the male (fig. 16) and female (fig. 17) imagines are given by Mr. G. C. Champion in the *Ent. Mo. Mag.*, 3rd ser., vol. 6, 1920, pp. 194–196, accompanied by two figures in text. In referring to this complete article I would like to add that by making a dissection of a (male) specimen and preparing the parts on a glass slide, I found after examination under the microscope that the two movable appendages on the apical joints of the maxillary and labial palps (fig. 16*a*) can hardly be characterised as "cheliform." One of these appendages is placed terminally on top of the last joint, and the other, somewhat smaller, is inserted antero-laterally in the middle of an obliquely situated, oval, light membrane; they cannot, therefore, be drawn against each other to form a clasping-structure.

EXPLANATION OF PLATES LXXXIX–XC.

(Drawings by the author.)

Psephenoides gahani, Champ.

PLATE LXXXIX.

FIG. 1. LARVA, ventral mouth-parts from below.
eli., eulabium; *g.*, galea; *gu.*, gula; *l.*, lacinia; *li.*, ligula; *m.*, mentum; *maa.*, maxillary articulating area; *pg.*, palpiger; *sm.*, submentum.

2. LARVA, mandible, exterior face, and right antenna.
D., dome-shaped tactile papilla; *s.*, supplementary appendix; 1, 2, 3, the three antennal joints.

3. LARVA, optical spot with vestiges of six lenses.

4. LARVA, distal end of the expansion of seventh abdominal segment, dorsal face.
Diat., Diatomaceae on the surface or hairs of the body.

5. LARVA, epipharynx and left mandible.

6*a*. LARVA, stalked and probably glandular sucking disks, face view.

6*b*. LARVA, sucking disks, in profile.

7. LARVA, maxilla, buccal face, and hypopharynx.
g., galea; *hyp.*, hypopharyngeal basis; *la.*, lacinia.

8. LARVA, right leg from below.

* Hubbard, G. H., "Habits of *Psephenus lecontei*, Lec." *The American Entomologist*, vol. 3, 1880, p. 73.

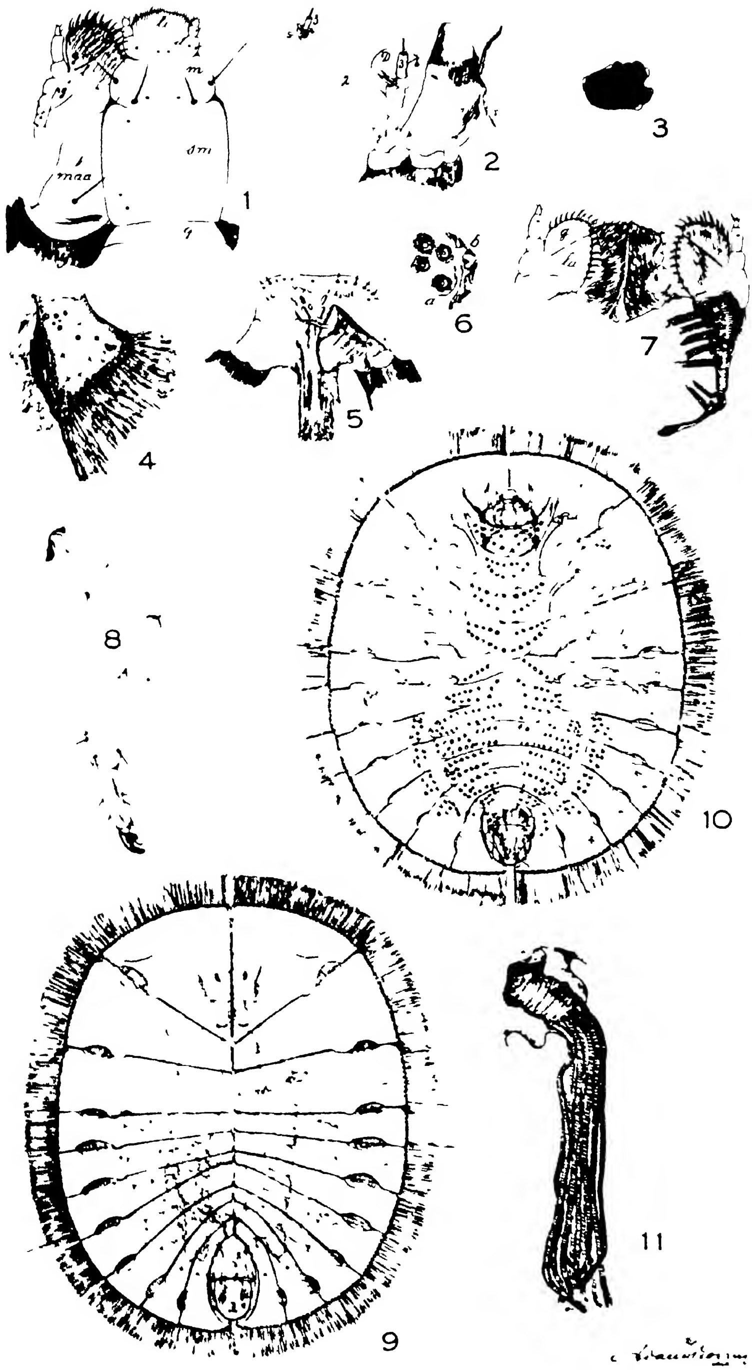
FIG. 9. LARVA, dorsal face.
sp., rudimentary spiracle of fourth abdominal segment; *Tr. S.*, tracheal main stem; *Ventr.*, ventriculum.

10. LARVA, ventral face.
c., coxa; *es.*, eusternum of prothorax; *ph.*, prehypopleurum; *poh.*, post hypopleurum; *ps.*, prothoracic presternum.

11. LARVA, gill-tassel. The distal branching of each gill-filament indicated by a small arrow.
t., short portion of tracheal main stem.

PLATE XC.

12. LARVA, dorsal face, showing the ordinary colour pattern of a mature larva.
13. PUPA, extracted artificially from a larva. Hairs and spines appressed to surface and directed toward the middle line of the body.
14. PUPA, dorsal face; actual length of the specimen about three millimetres; possibly a male pupa.
15. PUPA, ventral face; actual length of the specimen about four millimetres; female pupa as proven by the form of the antennae of the imago which in this specimen was formed inside of the pupal skin.
ala., hind wing; *ant.*, antennal sheath; *ely.*, elytron.
16. IMAGO—Male; *aede.*, aedeagus.
16*a*. IMAGO—Maxilla and Labium seen from the buccal cavity.
m., maxillary lobe; P_1, terminal appendage of fourth joint of maxillary palp; p_1, terminal appendage of third joint of labial palp; P_2, lateral appendage of fourth joint of maxillary palp; p_2, lateral appendage of third joint of labial palp.
17. IMAGO—Female.
17*a*. IMAGO—Basis of left anterior leg, facing upward.
c., coxa; *co.*, aperture in proximal end of coxa; *f.*, femur; *t.*, trochanter.



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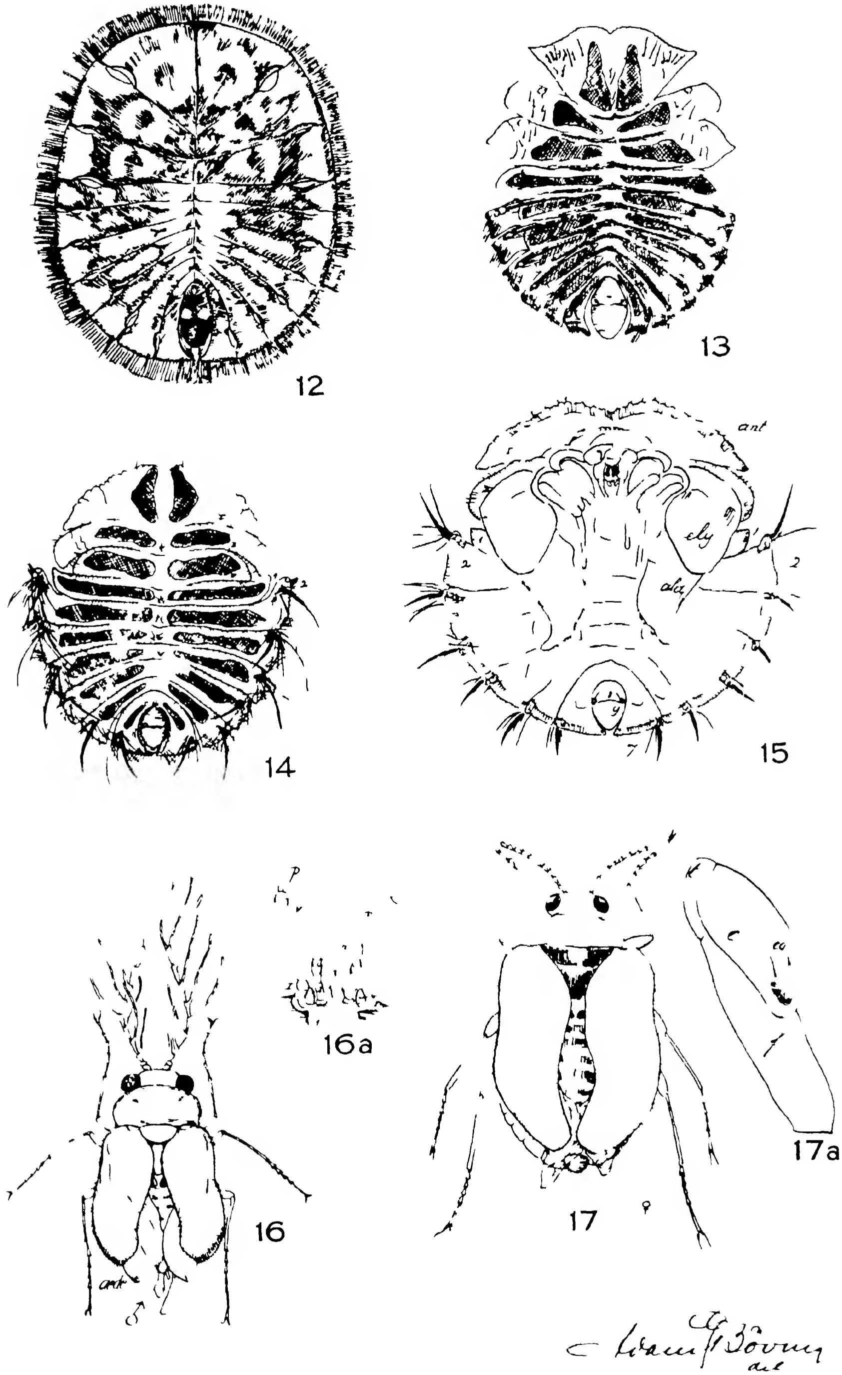
IMMATURE STAGES OF ESEPHENOIDES GAHANI



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IMMATURE STAGES OF PSEPHENOIDES GAHANI

ON THE BRITISH BITING MIDGES (DIPTERA, CERATOPOGONIDAE)

By F. W. Edwards.

(Published by permission of the Trustees of the British Museum.)

[Read October 6th, 1926.]

Plates XCI–XCII and Three Text-figures.

The present paper contains a brief systematic account of the adult features and habits of a group of insects whose study has hitherto been very much neglected in this country. The early British collectors (except Haliday) paid little attention to them, and Walker in his *Insecta Britannica* was only able to record a comparatively small number of species, most of his section dealing with these insects being compiled from Winnertz's monograph of the European species. Verrall in his list of 1901 included 47 established and 14 reputed British species, and in 1912 he recorded a few additions to this list; I have recently added a number of others. The following notes, which represent the results of a number of years' collecting, increase the total of recognised British species to 107, three of which are described as new. In addition to these at least a dozen others are in the British Museum collection awaiting determination; I have referred to these later on, in order to indicate where additions to the list may be expected, but have refrained from naming them either because the species are obscure or the available material scanty and unfit to describe. We may fairly assume that the full number of species existing within these islands is not far short of 150.

Although I have not given much introductory account of these insects (since this can be obtained from text-books and other works), I hope the diagnoses and keys to the species will be found sufficiently clear to enable even a beginner to recognise most of his captures; the determination need not present much difficulty to anyone possessing a binocular microscope or even a strong pocket lens. In the preparation of the figures of representative wings I have received much valuable assistance from Mr. G. Grace of Ilkley. These figures are all based upon photographs, but as we experienced great difficulty in obtaining prints which would show clearly all details of venation, pubescence and markings, most of them have been extensively touched up with pencil in order to bring out the salient points. I have further to acknowledge indebtedness to Messrs. H. Britten, R. Butterfield, J. W. Carr, C. A. Cheetham, J. E. Collin, P. H. Grimshaw, A. H. Hamm, L. G. Saunders and H. Scott, each of whom has presented material to the National Collection or lent specimens for examination.

The small bloodsucking midges so familiar to everyone in this country, together with a number of other species of different habits, many of them predaceous on other insects, were placed until recently in the large genus *Ceratopogon*, the genus being included with the non-biting dancing midges in the family Chironomidae. These species, however, exhibit such a considerable range of structure as well as of habits, that it is not surprising that recent authors have dismembered the old genus. Most of the divisions proposed by Kieffer are undoubtedly natural and are fairly easily defined, so that there is no doubt at all that they will be permanently adopted. On the other hand, the group as a whole is a compact one, and shows many striking differences

from the non-biting midges (*Chironomus*, *Tanypus*, etc.). This led Malloch in 1917 to propose the separation of this group from the Chironomidae as a distinct family, the Ceratopogonidae. The separation has not been generally adopted hitherto, but has much to recommend it, as the following statement of the differences between the two groups will show :—

Ceratopogonidae.	Chironomidae.
Head rounded behind.	*Head* flattened behind.
Mouth-parts complete, the mandibles well developed in both sexes and toothed; blade of maxilla present; second segment of palpus with sensory organ.	Mouth-parts reduced, the mandibles absent in both sexes; blade of maxilla wanting; second segment of palpus without sensory organ.
Antennal flagellum (with rare exceptions) with 13 segments in both sexes, the last 3 or 4 in the ♂ lengthened, and the last 5 in the ♀ more or less different in character from the others.	Antennal flagellum usually with 12 or 14 segments in the ♂, of which only the last 1 or 2 are lengthened; with 5–14 segments in the ♀, only the terminal one being different in character.
Thorax more rounded.	*Thorax* longer.
Pronotum with its anterior division small, placed low down, and hidden between the head and the scutum.	Pronotum with its anterior division larger, nearly always visible dorsally as a distinct collar.
Scutellum usually with bristles.	Scutellum with fine hairs only.
Postnotum gently rounded.	Postnotum more prominent.
Anepisternal cleft (*i.e.* the membranous area of the pleurae) smaller and differently shaped.	Anepisternal cleft large and triangular.
Sternopleurite (mesosternum) not very prominent, reaching only a little below the tip of the front coxa.	Sternopleurite very prominent, reaching much below tip of front coxa (with rare exceptions).
Abdomen often with pairs of transverse impressed areas.	*Abdomen* without transverse impressed areas.
Spermathecae strongly chitinised.	Spermathecae not or slightly chitinised.
Hypopygium more complicated, generally with distinct cerci, parameres and aedeagus.	Hypopygium simplified, generally without cerci, parameres or aedeagus.
Legs shorter and stouter, the hind pair the longest.	*Legs* longer and more slender, the front pair generally the longest.
Hind tibia with a double comb at the tip.	Hind tibia with a single comb or none.
Pulvilli never present.	Pulvilli often present.
Wings almost invariably superimposed over the back when at rest.	*Wings* never superimposed over the back.
Vein R_{2+3} absent, apparently owing to complete fusion with R_{4+5}.	Vein R_{2+3} generally present.
Media nearly always forked (the only exceptions being *Leptoconops* and *Brachypogon*, neither of which are British).	Media always simple.
Alula scarcely indicated, but this portion of the wing margin sometimes fringed.	Alula fairly prominent, but never fringed.
Squama small, sometimes with a tuft of hairs but never with a complete fringe.	Squama rather large and nearly always fringed.

Many of the distinctions mentioned in this list are no doubt of minor importance, but the sum of them seems amply sufficient to justify Malloch's conclusion. In several important respects the CERATOPOGONIDAE show less resemblance to the CHIRONOMIDAE than the latter do to the CULICIDAE. The two most obvious distinctions of the CERATOPOGONIDAE from the CHIRONOMIDAE are the complete mouth-parts and the forked media, both of which allow a very sharp line of division to be drawn. In the early stages the distinctions are less clear than in the adults, but even the larvae and pupae can be defined much more clearly than many groups of Cyclorrhaphous Diptera which are commonly accorded family rank.

The interpretation of the radial venation presents some difficulty, but it may probably be explained as originating from a type similar to that of the CULICIDAE, in which between the simple veins R_1 and R_{4+5} there is a forked vein R_{2+3}, both branches of which reach the wing-margin. The first modification of this arrangement is that R_2 shortens, turns backwards, and ends in R_1 instead of in the costa; this is practically the arrangement found in the TANYPODIDAE. While the CHIRONOMIDAE seem to have advanced from this stage by the suppression of R_2 and the retention of R_{2+3} as a thin simple vein, the CERATOPOGONIDAE seem to have lost R_3 and also the stem of R_{2+3} through their fusion with R_{4+5}, retaining R_2 as an apparent cross-vein connecting R_1 and R_{4+5}. As we cannot derive the CERATOPOGONIDAE directly from the TANYPODIDAE, the above interpretation of the radial veins indicates an early and quite distinct origin for this group and supports the family separation.

The modern classification of this group is due to Kieffer, and was first outlined by him in a key to the genera (*Ann. Mus. Nat. Hung.*, 1919); more recently (*Faune de France, Ceratopogoninae,* 1925) he has slightly modified and expanded his arrangement. The system adopted by Goetghebuer (*Ceratopogoninae de Belgique*, 1920) is practically the same. These three papers are the most important contributions which have appeared since Winnertz published his classical monograph of the genus *Ceratopogon* in 1852. I have for the most part accepted Kieffer's genera, but in a few cases the subdivisions he has proposed seem unnecessary, and I would therefore suggest including *Apelma* under *Forcipomyia*; *Kempia* under *Atrichopogon*; *Prokempia* under *Dasyhelea*; *Psilohelea*, *Anakempia* and *Isohelea* (perhaps also *Trishelea* and *Brachypogon*) under *Ceratopogon*; and *Probezzia* under *Bezzia*. Apart from this, I consider that Kieffer attached too much importance in his classification to the pubescence of the eyes and perhaps not enough to the venation of the wings. In one or two other cases Kieffer was mistaken in his application of the names. The reasons for the proposed changes are explained below. I have given in each case a fairly full diagnosis of the British genera which I would propose to recognise, and have compiled a simplified key indicating their more outstanding characteristics.

The insects of this family fall into two main groups. First we have species with comparatively short and hairy body; broad and usually hairy wings, in which the costa is often short and the second radial cell reduced in length, the anal vein being straight and the anal area large; the femora and claws unmodified; the membranous area of the pleurae (anepisternal cleft) large and vertical. The females of this group frequently have bloodsucking habits, attacking either vertebrates (as does *Culicoides*) or else other insects much larger than themselves (as do *Forcipomyia* and some *Atrichopogon*). The larvae and pupae of this group are often terrestrial, and though very varied in form the larvae are never extremely long and worm-like. In the second group the insects are more slender in form and much less hairy; they have narrower,

bare wings, in which the costa reaches well beyond the middle and the second radial cell is long, the anal vein bent upwards near the middle; either the femora or the claws, or both, modified in various ways; anepisternal cleft narrow and oblique, and lateral piece of scutum (paratergite) broad. The females of this second group are all predaceous on other small insects, especially CHIRONOMIDAE; the larvae and pupae are always strictly aquatic, the larvae extremely long and worm-like.

Crampton was so much impressed by the differences between these two groups in thoracic structure (which as seen above is only one of several noteworthy differences) that he has proposed in a recent paper to form a family JOHANNSENOMYIIDAE for the genus *Johannsenomyia* and its allies. But this separation cannot be justified, because all the gaps are completely bridged by a few small genera (especially *Ceratopogon* and *Stilobezzia*) which are intermediate between the two main groups.

KEY TO GENERA.

1. Empodium as long as the claws (except in ♂ of subgenus *Apelma*) . . 2.
   Empodium very short or absent . . . . 4.
2. Second radial cell short; costa reaching to about middle; wings with dense macrotrichia all over . . . . *Forcipomyia*.
   Second radial cell long and narrow . . . . 3.
3. Costa to about middle; macrotrichia of wings dense . . . . *Lasiohelea*.
   Costa reaching well beyond middle; macrotrichia sparser, sometimes absent . . . . *Atrichopogon*.
4. Costa to about middle; second radial cell short and square-ended, the first obliterated; macrotrichia usually dense; eyes pubescent *Dasyhelea*.
   Costa generally reaching well beyond middle; venation otherwise . . 5.
5. Humeral pits present and conspicuous; microtrichia of wings distinct; claws of female small and equal . . . . *Culicoides*.
   Humeral pits absent, or else microtrichia of wings are absent, or the claws of female very unequal . . . . 6.
6. The two radial cells small, about equal in size; wings milky, without microtrichia; legs not thickened . . . . *Ceratopogon*.
   At least the second radial cell much longer than broad; or wings with distinct microtrichia and legs modified . . . . 7.
7. Hind femora noticeably thicker than the others . . . . 8.
   Hind femora not thickened . . . . 10.
8. Hind femora very thick and spiny beneath; hind tibiae not thickened. *Serromyia*.
   Hind femora not spiny; hind tibia somewhat thickened . . . . . . 9.
9. M_2 complete . . . . *Monohelea*.
   M_2 broadly interrupted at the base . . . . *Schizohelea*.
10. Median fork with rather long stem . . . . *Stilobezzia*.
    Median fork sessile or at most with very short stem; wings bare . . 11.
11. Two radial cells (R_2 present) . . . . 12.
    One radial cell (R_2 absent) . . . . 16.
12. Front femora unarmed . . . . 13.
    Front femora with spines beneath . . . . 15.
13. Costa produced much beyond R_{4+5} . . . . *Neurohelea*.
    Costa ending at tip of R_{4+5} as usual . . . . 14.
14. Last segment of front tarsi much swollen . . . . *Clinohelea*.
    Last segment of front tarsi not swollen . . . . . . *Johannsenomyia*.
15. Fourth tarsal segment short but cylindrical . . . . *Sphaeromias*.
    Fourth tarsal segment distinctly cordiform or bilobed beneath . *Palpomyia*.
16. Scutum with short bristles in addition to the pubescence . . . *Dicrobezzia*.
    Scutum with pubescence only . . . . *Bezzia*.

A further reduction of these genera might possibly be made by the inclusion of *Monohelea* and *Schizohelea* in *Serromyia*; and of *Neurohelea* and *Clinohelea* in *Johannsenomyia*, and *Sphaeromias* in *Palpomyia*. But all the genera from *Serromyia* to *Bezzia* form a compact group, and if we commence to condense we might end in being compelled to recognise only a single genus. Some division of this large group is clearly desirable, and I therefore adopt the genera practically as defined by Kieffer.

Most of our species have been described in the works of Goetghebuer, or in Kieffer's revision in the *Faune de France*. The keys given by these authors, however, are far from satisfactory, and I have therefore entirely remodelled them, where possible dividing up the species of each genus into groups.

FORCIPOMYIA (Mg.), Kieff.

(Incl. *Apelma*, Kieff.; *Euforcipomyia*, Mall., and *Thyridomyia*, Saund.; *Ceratopogon*, Kieff. 1917.)

(Plate XCI, fig. 1, wing of *F. brevipennis*.)

This genus is placed by Kieffer in a group of genera distinguished by the possession of a well-developed hairy empodium, the other members of the group being *Atrichopogon*, *Kempia* and *Lasiohelea*. The arrangement is doubtless a natural one, as it is supported by the characters of the early stages. I think, however, that *Apelma* also belongs to this group rather than to the *Culicoides* group of genera. Saunders has recently shown that although the empodium is absent in the male *Apelma* it is present and well developed in the female, and as the other adult characters of *Apelma* are so similar to those of *Forcipomyia* I would include it in this genus for the present.

The following general description will apply to most species of *Forcipomyia* :

General diagnosis.—Body short, stout, and very hairy. Eyes bare. Female antennae with dense verticils on segments 2–9, less distinct verticils (if any) on 10–14, these segments also being differently shaped, usually more or less cylindrical. Male antennae with a single verticil on each of segments 11–14, 11–13 swollen at the base, 11 generally very long. Mesonotum generally hairy all over, and with longer bristles among the hairs. No humeral pits. Hypopygium not inverted; ninth tergite large; parameres usually distinct and separate. Abdomen and legs with long bristles, especially in the males, the bristles being present on some of the tarsal segments as well as on the tibiae. Femora somewhat thickened. Wings broad; the anal area large but the angle very obtuse (as shown in figure of *F. brevipennis*). Surface densely covered with close-lying macrotrichia, and also with fine microtrichia. Costa reaching about to the middle of the wing. First radial cell very narrow and almost obliterated (rarely if ever entirely so); second small but distinct; tip of R_{4+5} nearly always curved up to the costa and not sharply angled. An " intercalary fork " in cell R_5 (usually hidden by dense hair). Cross-vein very oblique. Median fork with very short stem, which is only faintly marked; branches diverging slightly. Base of cubital fork just before, below, or just after the level of the end of the costa. Alula short but fringed. Squama with a tuft of hair.

The species of this genus exhibit a considerable range of structure, the most noticeable differences being in the relative proportions of the first two segments of the hind tarsi. We may divide the British species quite readily into four groups, based on the length of the first hind tarsal segment in relation to the

second, which I will express as a decimal and designate T.R. (tarsal ratio). This ratio varies but little in each species, though there is often a slight difference between the two sexes (as for example in *F. ciliata* and *F. brevipennis*). Although the dividing lines between the four groups may appear rather arbitrary on paper it will be found in practice that they are quite easy of application.

Group A.

T.R. 0·4–0·65.

In this group I have only identified two British species, but there are probably one or two others. Other species of the group occur in Europe as well as in North and South America, India, Ceylon and the Malayan region, all being rather closely similar. Several of them have been observed sucking the juices from large smooth caterpillars (generally Lepidoptera such as Sphingids, but in one case a saw-fly larva); this habit has not been observed in any species of the other groups of this genus, nor in any of the other Ceratopogonines. None of these species have been reared.

1. **F. alboclavata,** Kieff. (*canaliculata*, Goet.). Scutum blackish, hair and bristles all golden. Lateral membrane of abdomen with golden hair. Femora with a broad though ill-defined blackish ring near the tip, and tibiae with a similar ring near the base. T.R. about 0·4. Wings with a patch of black hair over and around the radial cells, the rest of the hair not so dark. Halteres whitish. Isle of Arran (*Waterston*).

2. **F. pallida** (Winn.). Scutum greyish, hair and bristles all pale. Lateral membrane of abdomen with dark hair. Legs all pale; T.R. about 0·6. Wing-hair uniform, not very dark. Halteres brownish. Hitchin, Herts. (*Edwards*); Torcross, S. Devon (*Yerbury*). Other specimens differ either in having the T.R. less (0·4) or the halteres whitish, but we have not sufficient material to decide whether these belong to distinct species or are varieties of *F. pallida*; some were incorrectly determined by Verrall as *vexans*, Zett.

Group B.

T.R. 0·75–1·2.

This group includes the majority of species of the genus, and all the more typical forms. Among the females we may distinguish between those which have long erect fusiform scales on the tibiae, and those which have not. A division on this character is clearly a natural one, for as may be seen from the researches of Saunders on the early stages (*Parasitology*, vol. xvi, March 1924), the larva of the scaly-legged species all have two malpighian tubules and hairs *b* and *d* of the abdomen arising from separate tubercles, while the others have three malpighian tubules and hairs *b* and *d* arising from a common base. As, however, the males of all species lack the tibial scales, and I have not been able to discover a correlated character in that sex, I have prepared a somewhat artificial key based on characters applicable to both sexes. Apart from the named species mentioned in the key, I am acquainted with several others which I have not succeeded in naming; these are referred to in the notes.

Nothing remarkable has been recorded as to the feeding-habits of the adults. They are not blood-suckers; Meigen records *F. bipunctata* as biting, but this was probably an error.

MALES AND FEMALES.

1.	Mesonotum shining black, hair and bristles (when present) all black	2.
	Mesonotum not shining black, or else with pale hair	4.
2.	A spot of yellowish hair on front margin of wing; mesonotum bristly	3.
	No wing-spot; mesonotum bare (according to description)	*braueri*, Wasm.
3.	Wing-spot larger, placed beyond second radial cell	*nigra*, Winn.
	Wing-spot smaller, placed partly on second radial cell	*brevipennis*, Mcq.
4.	A spot of yellow hair over second radial cell	5.
	Wing-hair all dark	7.
5.	Shoulders extensively yellow; mesonotum shining, bristles all dark.	*pulchrithorax*, Edw.
	Shoulders not yellow	6.
6.	Mesonotum shining, with black bristles and yellow hair	*bipunctata*, L.
	Mesonotum dull, bristles and hair golden	*tenuisquama*, Kieff.
7.	Mesonotum slightly shining, bristles and hair all pale	*ciliata*, Winn.
	Mesonotum dull	8.
8.	All thoracic bristles yellowish	*radicicola*, Edw.
	Bristles black, the shorter hair pale	9.
9.	Hair at tips of femora conspicuously pale, almost silvery	*regulus*, Winn.
	Hair at tips of femora not obviously pale	10.
10.	Shoulders reddish; legs pale	*kaltenbachi*, Winn.
	Shoulders not distinctly reddish; legs dark brown	11.
11.	T.R. (♂) about 0·9	*myrmecophila*, Egg.
	T.R. (♂) about 0·75	*picea*, Winn.

(a) *Female with scales on tibiae.*

1. **F. ciliata** (Winn.) (*boleti*, Kieff.). Close-set rows of scales on the dorsal surfaces of *all* the tibiae of the female. T.R. about 1, but varies somewhat. One of our largest species; wing over 2·5 mm. Larvae usually in decaying fungi. A specimen of *ciliata* in the British Museum determined by Winnertz himself agrees with our material and also fairly closely with Kieffer's description of *boleti*; in spite of Kieffer's contention that the two are distinct there can be little doubt that they are really the same. Common.

2. **F. pulchrithorax,** Edw. Scales present on all the tibiae of the female, but few in number and not easily seen. T.R. about 0·75. Wing under 1·5 mm. Very distinct by the yellow markings on the thorax, which are more extensive in the female. Larvae in running sap of various trees. E. England.

3. **F. bipunctata** (L.) (*trichoptera*, Mg.). Scales numerous on the four posterior tibiae, but none on the front pair. T.R. about 1. Yellow spot over second radial cell very distinct, base of wing also distinctly yellow. Abdomen either all dark, or tergites with hind borders pale. Very common; larvae under bark; in old manure heaps, etc.

This is the species identified by Walker and Verrall as *F. bipunctata*, and it certainly seems to fit Linnaeus' brief diagnosis better than any other, especially as he mentions the yellow base of the wing and the shining thorax ("thorax levis"). It is certainly the same as the species Goetghebuer has described as *trichoptera*, Mg., but this name is open to more objection than *bipunctata*. It was first used by Meigen in 1804; in 1818 he repeated his diagnosis but replaced the name *trichopterus* by Linnaeus' *bipunctata*. At the same time he published another description by Wiedemann of "*trichopterus*, Hgg." Since this description of Wiedemann's does not mention the pale wing-spot it probably refers to

another species, to which the name *trichopterus* cannot be applied legitimately, since it had previously been used by Meigen. Goetghebuer in his revision of Meigen's types refers to specimens of "*bipunctata*" and "*trichoptera*, Hgg.," stating that they represent different species. However, he implies that both have the costal spot, and therefore the *trichoptera* mentioned was probably Meigen's 1804 species and not Wiedemann's; that is to say it was Meigen's 1818 interpretation of *bipunctata*. The other specimens actually labelled *bipunctata*, if really belonging to a different species (the tibial scales of the single female may have been rubbed off) should be known as *disticta*, Kieff.

I have discussed the use of the name *bipunctata* at some length, because this species must be regarded as the type of the genus. Coquillett indeed designates *Ceratopogon ambiguus*, Mg., as the genotype, but this designation cannot stand. In the first place Meigen's *ambiguus* has never been recognised, and cannot be, since the description is quite inadequate and the type is lost. Secondly, *bipunctata* was mentioned by Westwood as the type of *Labidomyia*, Stephens, and as *Labidomyia* was merely a substitute name for *Forcipomyia*, *bipunctata* automatically becomes the type of *Forcipomyia*.

4. **F. tenuisquama,** Kieff. (? *bipunctata*, Zett. *nec* L.). Tibial scales as in *F. bipunctata*, also most other structural details, but integument of mesonotum dull, and vestiture entirely golden and denser; size rather larger than the average *bipunctata*, and hypopygium differs. Common on windows at Letchworth, Herts. (*Edwards*).

5. **F**. sp. indet. Only a very few pale hairs over radial cell, not forming a distinct spot. Scutum dull and golden-haired. Hind borders of abdominal tergites very broadly yellow. Knees and tips of tibiae conspicuously yellow. Hypopygium almost as in *F. bipunctata*. One male on window at Letchworth (*Edwards*).

6. **F**. sp. indet. Female with 3–5 long scales on hind tibiae, none on anterior pairs. Wing under 1·5 mm. long, hair all dark. Scutum dull brownish, hairs and bristles pale. Legs uniformly pale. Letchworth (*Edwards*); Cambridge, bred from elm sap (*Jenkinson*).

(b) *Female without scales on tibiae.*

1. **F. braueri,** Wasm. Said to have a bare scutum, which if true will separate it at once from the other British species. Larvae in nests of *Formica fusca*. Once obtained at Grassington (*Butterfield*). I have not seen a specimen.

2. **F. nigra** (Winn.). The ♀ has a large yellowish wing-spot immediately beyond the radial cells; the ♂ has the anterior margin of the outer half of the wing whitish-yellow. Anal area of wing not distinctly paler. Tarsi dark; T.R. about 0·8. Larvae on old fallen branches, especially oak. Common.

3. **F**. sp. indet. Like *nigra*, but smaller, less bristly, costal hair dark beyond the small spot, pleural membrane larger and yellow. Letchworth, 1 ♂ (*Edwards*).

4. **F. brevipennis** (Macq.) (*lateralis*, Bouché; ? *geniculatus*, Duf.). Wing-spot smaller than in *F. nigra*; anterior margin beyond the spot dark in both sexes. Anal area of wing pale. Tarsi reddish; T.R. about 1·1. Larvae in old horse and cow-dung in fields. Common.

5. **F**. sp. indet. Wing-spot small but distinct, placed mainly on outer radial cell. Scutum shining dark brown, with yellowish-brown hair and longer black bristles. Shoulders orange, also a large pleural patch. T.R. about 0·7. Nethy Bridge, vi.1907, 2 ♀ (*Sharp*). This is possibly *F. disticta*, Kieff.

6. **F. regulus** (Winn.). A small species, distinct by venation and antennae. Both radial cells almost obliterated. Segments 2–9 of female antennae flask-shaped, with necks as long as the basal part; 10–14 together barely half as long as 2–9. Second palpal segment hardly swollen. Cambridge (?), 5.x.1911, 1 ♀ (*Jenkinson*).

7. **F. picea** (Winn.) (*latipalpis*, Kieff.; *corticicola*, Kieff.). A rather large species, wing about 2 mm. Shoulders at most indistinctly reddish in the ♀ not in the ♂. Larvae under bark. Common. The specimens recorded as *F. corticis*, Kieff. (Edwards, 1916) are *F. picea*.

8. **F. kaltenbachi** (Winn.). Shoulders distinctly reddish in both sexes, and legs much paler than in *F. picea*; hypopygium and larvae also differ. Larvae recorded by Winnertz from running sap of poplar; our specimens were obtained from under pine bark at Woking (*Champion*); the identification must therefore be considered doubtful.

9. **F. myrmecophila** (Egg.). Closely resembles *F. picea*, but hypopygium differs, and the ♂ seems to have a rather longer first hind tarsal segment, though a ♀ in Mr. Collin's collection is quite similar to *picea*. Larvae in nests of *Formica rufa*.

10. **F.** sp. indet. Very similar to *F. picea*, but hypopygium differs. Larvae under bark. Oxford (*Hamm*).

11. **F.** sp. indet. Like *picea*, but much smaller, and ♂ clasper quite different, the basal half being much swollen, the end half suddenly narrower. Radwell, Herts. 2 ♂ 1 ♀ (*Edwards*).

12. **F. radicicola,** Edw. (? *autri-jovis*, Kieff.). Differs obviously from the last five in the yellow scutal and scutellar bristles, also in the shape of the antennal segments of the ♀, 2–9 being more flask-shaped. Larvae in old tap-roots of *Arctium*, *Angelica*, etc. E. England.

Group C.

T.R. 1·35–1·75.

The species of this group present rather noticeable differences from those of the last two groups, both in the male hypopygium and in the larvae and pupae; Dr. L. G. Saunders has therefore suggested that they should form a separate subgenus. If so, Malloch's name *Euforcipomyia* will probably be found applicable, as the type species (*hirtipennis*, Mall.) appears similar to our *F. titillans*.

In this group I have only distinguished two British species; two others (*alacer*, Winn., and *halterata*, Winn.) were recorded from England by Walker, but probably wrongly; I have seen no specimens, other than German co-types from Winnertz in the British Museum. The terminal segments of the female antenna are rather short.

1. **F. crassipes** (Winn.). Scutum greyish, scarcely shining. Scutellum brownish-yellow. T.R. about 1·35. Oxford, 1 ♂ (*Hamm*). Ffrith, N. Wales, 1 ♀ (*Edwards*).

2. **F. titillans** (Winn.) (? *divaricatus*, Winn.). Scutum and scutellum shining black, hairs brownish. T.R. about 1·75. Rather common.

I accept Verrall's identification of this species, but note that it does not entirely agree with Winnertz's description, the first radial cell of the female being little if any wider than in other species of the genus. The macrotrichia of the wings, however, are rather less dense than usual, so that the veins show more clearly; possibly this may have misled Winnertz into thinking the venation different and exaggerating the appearance in his figure. The costa

in the female ends in the middle of the wing above the base of the cubital fork, in the male it is shorter, ending well before the base of the fork; the male answers rather well to Winnertz's description and figure of *divaricatus*, except that the median fork is normal and not suddenly widened at the tip.

Group D.

T.R. 2 or more.

The three British species of this group are not closely related, and two of them have been placed by Saunders in separate genera: *palustris* in *Thyridomyia* and *papilionivora* in *Apelma*. But although these genera appear rather well defined on larval characters, and the distinction is supported by differences in the hypopygium, I prefer not to separate them from *Forcipomyia* because of the close similarity in the wings.

1. F. **murina** (Winn.). Scutum mouse-grey, dull. Scutellum yellow. Only the first three or four basal segments of the female antenna globular, the rest longer. Superficially similar to *F. crassipes*. Letchworth (*Edwards*); Oxford (*Hamm*).

2. F. **palustris** (Saund.). Scutum and scutellum shining black. Segments 2 9 of female antenna globular, together about as long as 10–14. Larvae on mossy wood. Rather common. This is the species previously recorded from Britain as *frutetorum*, Winn., but there are differences between the two which have been figured by Saunders.

3. F. **papilionivora,** Edw. (? *Apelma auronitens*, Kieff.; ? *Trichohelea tonnoiri*, Goet.). Scutum uniformly brownish, densely clothed with bright golden hair. Scutellum yellow. Segments 2–9 of female antenna broader than long, and together hardly half as long as 10–14. N. Wales (*Newstead*).

The females suck the wing-veins of Lepidoptera. Males have not been found in Britain, but it is probable that *auronitens*, Kieff. (described from the male only), is the same species; if so the latter name must be used. As there may be several related European species I have not at present adopted Kieffer's name. In the subgenus *Apelma* the males have no empodium, although it is well developed in the females.

Lasiohelea, Kieff.

Resembles *Forcipomyia* and *Atrichopogon* in the possession of a well-developed empodium. Differs from *Forcipomyia* in venation, the second radial cell being long and narrow, much longer than the first; also in the form of the female antennae, segments 2–9 being rounded or transverse and 10–14 long and cylindrical, as usual in *Atrichopogon*. Differs from *Atrichopogon* in having the wings densely covered with macrotrichia, and the first radial cell obliterated, as in *Forcipomyia*.

The genus includes a small number of species, most of which are bloodsuckers; the early stages are unknown. Kieffer (1925) includes five species here, but I consider three of these to be wrongly placed; *titillans* and *halterata* belong rather to *Forcipomyia*, from which they do not differ in venation; *saltans* according to Winnertz's description has the wing of a *Culicoides*, and if, as seems possible, Winnertz made a mistake in including it among the species with a hairy empodium, it may be the same as *C. minutissimus*.

I mention *Lasiohelea* in this paper because *L. velox* was included by Verrall in his list of British Diptera, but I have seen no British examples.

ATRICHOPOGON, Kieff.

(Incl. *Kempia*, Kieff., and *Gymnohelea*, Kieff.; *Ceratopogon*, Mall. 1915.)

(Plate XCI, fig. 2, wing of *A. lucorum.*)

A rather well-defined genus having a large empodium as in *Forcipomyia*, but differing in venation and in having the macrotrichia of the wings comparatively sparse and suberect. Kieffer and Goetghebuer have separated under the name *Kempia* a number of species with hairy or pubescent eyes, but as has been pointed out by Ingram and Macfie no sharp distinction can be made between the two groups, and there is no structural difference of importance to distinguish them. Similarly Kieffer's *Gymnohelea*, based on species which have lost all the macrotrichia of the wings, cannot be maintained.

General diagnosis.—Body short and rather stout, but not very hairy. Eyes hairy or bare. Female antennae with the last five segments cylindrical, and always much longer than the others, which are globular or transverse. Male antennae with slight verticils on segments 11–14, 11 not greatly lengthened. Mesonotum bare or with fine short hairs only. Legs rather slender, with few or no long hairs; first hind tarsal segment always at least twice as long as the second. Wings broad, anal area more rounded than in *Forcipomyia*. Microtrichia always distinctly visible under a magnification of 100; macrotrichia less dense and also finer and more erect than in *Forcipomyia*, often confined to the tip of the wing or even entirely absent, and usually less numerous in the male than in the female. Costa reaching beyond the middle of the wing, generally to two-thirds; second radial cell long, generally twice as long as the first, or more. A conspicuous forked fold (the "intercalary fork") in cell R_5. Cross-vein not very oblique. Median fork with short stem, lower branch not or scarcely interrupted at base. Anal vein straight. Alula and squama bare.

The species of *Atrichopogon* are mostly very similar in appearance and difficult to distinguish satisfactorily; those occurring in Britain require much closer study before they can be properly understood. The adults are frequently found in large numbers (both sexes and often several species together) on the heads of Umbelliferae, while some species appear specially attached to certain flowers, such as honeysuckle. One has been recorded as attacking oil-beetles, but this habit has not been observed in any British species.

Subgenus **Kempia,** Kieff.

Eyes distinctly though finely pubescent all over. Sixth abdominal sternite of female normal. Macrotrichia present at tip of wing, at least in female.

1. **A.** (**K.**) **pavidus** (Winn.). Wings with macrotrichia in the tips of cells R_5 and M_1, rather variable in number and usually fewer in the male. Sixth sternite of female normal; ninth tergite of male broad and blunt-ended. As in the other British species of the subgenus the mesonotum is blackish, somewhat shining, and there are four scutellar bristles, the outer pair being much shorter than the inner. Segments 10–14 of female antennae gradually lengthened, 10 considerably shorter than 12. Common, especially on honeysuckle flowers.

Some females from Radwell, Herts. (*Edwards*) possibly belong to a distinct species; they have the last five antennal segments longer and subequal in length.

2. **A.** (**K.**) **aethiops** (Goet.). Very similar to *A. pavidus*, differing almost solely in the hypopygium, the ninth tergite being triangular and pointed. Letchworth district (*Edwards*).

3. **A. (K.) fuscus** (Mg.). Wings devoid of macrotrichia in the male; female with rather numerous macrotrichia towards the tips of cell R_5 and M_1, and also in cell M_2, besides a few in the anal cell. Sixth sternite unmodified. Segments 2–9 of female antennae broader than long. Rather common. Larvae aquatic.

4. **A. (K.) brunnipes** (Mg.). Similar to *A. fuscus*, but segments 2–9 of female antennae longer than broad. Recognised as British by Verrall; I have not met with it.

5. **A. hamiferus** (Goet.). Wings of female devoid of macrotrichia (in the type). Sixth sternite with a hook-like appendage bearing a few small spines at its tip. Male unknown. Corriegills, Isle of Arran, 1 ♀ (*Edwards*). Another ♀ from Windermere (*Edwards*) has a similar abdominal appendage, but the wings have a number of macrotrichia at the tip.

6. **A. (K.) appendiculatus** (Goet.). Wings of female devoid of macrotrichia. Sixth sternite with an appendage which is broader and straighter than that of *A. hamiferus*, and terminates in a tuft of large spines. Seventh sternite with a pair of spines. Male unknown. Oxford, 1 ♀ (*Hamm*).

7. **A.** (**K.**) sp. indet. Resembles *A. appendiculatus*, but smaller; microtrichia of wings coarser; appendage of sixth sternite of female rather different; seventh sternite with numerous spines. Bonhill, Dumbarton, 1 ♂ 2 ♀ (*Malloch*).

Subgenus **Atrichopogon**, Kieff.

Eyes either entirely bare, or with slight pubescence on the lower part only.

1. **A. trifasciatus,** Kieff. Differs from all the other British species of the genus in its colour: scutum yellowish, with three separate blackish stripes; scutellum yellow. Ninth tergite of male truncate, corners a little produced; clasper trilobed at tip. Horrabridge and Aviemore, Inverness (*Collin*).

2. **A. minutus** (Mg.). Differs from all the remaining species in its smaller size (wing under 1·5 mm.), and also in having only two bristles on the scutellum, the lateral pair being absent. Thorax shining black; legs yellow; wings either quite bare, or (in some females) with a few macrotrichia at the tip. Rather common.

3. **A. winnertzi,** Goet. (? *lucorum*, Winn.). As in the following species the scutum is dark brownish, scarcely shining; scutellum with four equal bristles. Proboscis distinctly shorter than the height of the head. Macrotrichia in the female extending over much more than half the wing; in the male numerous towards the tip and filling the intercalary fork. Segments 2-9 of female antennae hardly broader than long. Rather common.

4. **A. lucorum** (Mg.), Goet.? Resembles the last, but proboscis rather longer; segments 2–9 of female antennae more transverse; macrotrichia of male wings less numerous, covering only about half the area within the intercalary fork. Legs dark. Second radial cell much longer than the first (hence the doubt as to the determination; in *A. sylvaticus*, Winn., which Goetghebuer and Kieffer give as a synonym of *lucorum*, the two radial cells are of equal length). Common. Larvae found in a hollow tree occupied by ants (*Donisthorpe*).

5. **A.** sp. indet. Similar to the last, but smaller and legs pale yellowish. Proboscis as long as the height of the head. Babraham, Cambs., and Letchworth, Herts. (*Edwards*). Larvae on fallen logs.

6. **A. rostratus** (Winn.). Similar to the last two, but larger, and with fewer macrotrichia on the wing of the female, none at all in the male. Proboscis as long as the height of the head or slightly longer.

DASYHELEA, Kieff.

(*Pseudoculicoides*, Mall.; *Prokempia*, Kieff.)

(Plate XCI, fig. 3, wing of *D. holosericea.*)

A genus which is somewhat intermediate between *Forcipomyia* and *Culicoides*, having a venation similar to the former, but lacking the empodium as in the latter; distinguished from both by the pubescent eyes and other details. There does not appear to be any important distinction between *Dasyhelea* and *Prokempia*; the reduction in the number of macrotrichia on the wings of the latter is not a sufficient reason for separating it from *Dasyhelea*.

General diagnosis.—Body less stout and hairy than in *Forcipomyia*. Eyes finely pubescent. Female antennae with the terminal segments not very dissimilar to the basal ones, generally all with verticils. Male antennae generally with two verticils on each of segments 11–13. Mesonotum usually without long bristles. No humeral pits. Hypopygium much as in *Forcipomyia*. Legs rather slender; first hind tarsal segment always at least twice as long as the second. Wings broad, with very fine microtrichia, and with macrotrichia over part or all of the surface. Costa reaching about to middle of wing. First radial cell obliterated; second usually distinguishable, but always very small and square-ended. Intercalary fork present, but not conspicuous. Cross-vein very oblique, and the basal cell therefore narrow. Median fork sessile or with very short stem, branches slightly divergent. Anal vein straight. Anal angle obtuse as in *Forcipomyia*. Alula bare, squama usually with a small hair-tuft.

Kieffer divided the genus according to whether the macrotrichia of the wings are dense and decumbent (*Dasyhelea*) or sparse and suberect (*Prokempia*), the species of *Dasyhelea* being further grouped into those with and without a radial cell. Neither of these characters offers a satisfactory basis for a division, the first because of intermediate conditions and sexual differences, the second because a radial cell is probably present in every species, though often difficult to detect unless the wing is placed perfectly flat.

The genus is cosmopolitan and includes a large number of described species. The habits of the larvae are varied, many being aquatic or subaquatic, others (or even the same species) living in slightly moist decaying vegetable matter. The feeding habits of the adults are little known. One or two records exist of the females sucking blood, but none of the European species have been observed to do this.

I have determined eight species, but probably a number of others will be distinguished when they have received closer study. The species of the *versicolor* group are particularly difficult to separate satisfactorily.

KEY TO DETERMINED SPECIES.

1.	Scutum distinctly shining	2.
	Scutum quite dull	5.
2.	Macrotrichia of wings reduced, bare lines adjoining all the veins . .	3.
	Macrotrichia dense and decumbent, no bare lines	4.
3.	Scutum wholly black	*scutellata*, Mg.
	Shoulders largely yellow	*flaviventris*, Goet.
4.	Scutellum blackish	*polita*, Edw.
	Scutellum yellow	*notata*, Goet.

5. Scutum black, without bluish tinge; segments 2–9 of ♀ antennae nearly globular, 10–14 almost cylindrical . . . . 6.
Scutum generally bluish-grey with changing grey reflections; segments 4–13 of ♀ antennae flask-shaped, with long sense-bristles . . . . 7.
6. Radial cell considerably longer than broad . . . . . *holosericea*, Mg.
Radial cell almost square . . . . *flavoscutellata*, Zett.
7. Front tibia with a dark ring in the middle . . . . . . *dufouri*, Lab.
Front tibia without dark ring in middle . . . . . . *versicolor*, Winn.

The *Ceratopogon neglectus* recorded by Walker was *Forcipomyia brevipennis*.

1. **D. scutellata** (Mg.). Scutum brilliantly shining and almost bare, with a metallic bluish tinge, scutellum yellow. Femora blackish. Radial cell square. New Forest, 1 ♂ (*Sharp*).

2. **D. flaviventris**, Goet. Scutum shining, but without blue tinge; three fused black stripes leaving shoulders and two patches before scutellum bright yellow; scutellum and halteres also bright yellow. Legs pale. Letchworth, 1 ♀ (*Edwards*); Cambridge, 1 ♀ (*Jenkinson*).

3. **D.** sp. indet. Like the last, but base of cubital fork well beyond end of costa, and no macrotrichia in anal cell. Windermere, 4 ♂ (*Edwards*).

4. **D. polita**, Edw. Wholly blackish, including legs and scutellum; slight grey reflections on scutum. Radial cell much longer than broad. Wing-length 1·5–1·8 mm. Arran (*Edwards*).

5. **D. notata**, Goet. Similar to last but scutellum clear yellow, and wing-length 1–1·2 mm.

6. **D. holosericea** (Mg.) (? *aestiva*, Winn.; ? *pratensis*, Goet.). This is a variable species, unless there are two or three closely allied. The darkest males are almost wholly black, only the tarsi and halteres being brownish, these apparently agreeing with Meigen's type. Females usually have the scutum with changeable grey-reflections, appearing striped in some aspects; scutellum yellow; legs brownish with whitish tarsi; these answer fairly well to Winnertz's *aestiva*. Some males are coloured like the females, and a few females are as dark as the darkest males, but variation seems continuous in both sexes. The radial cell in the female is blackish (veins and membrane). Rather common.

7. **D.** sp. indet. Similar to the last in size, venation and antennae, but scutum brown, and macrotrichia of wings less numerous, narrow bare lines adjoining the veins. Corriegills, Arran, 1 ♀ (*Edwards*). I have recorded this specimen as *D. diplosis*, Kieff., but it is more probably another species.

8. **D. flavoscutellata** (Zett.) (*egens*, Winn.). Smaller than *holosericea*, and markings of scutum less obvious. Common, especially in coast marshes.

9. **D. dufouri** (Laboulbène) (*sensualis*, Kieff.; *bilineata*, Goet.). The largest British species. Scutum always with a distinct bluish tinge; when seen obliquely from in front with a pair of rather narrow blackish lines close together in the middle, somewhat divergent in front and behind; other irregular dark markings. Scutellum yellow at the sides. Legs yellow with dark rings, the one in the middle of the front tibia always distinct, and distinct pre-apical yellow ring on the front femora; in pale specimens the middle rings on the four posterior tibiae are indistinct, and in some males the femora and tibiae are mainly dark. Rather common. British Museum material includes specimens bred from decaying roots of *Spiraea*, and from scum on the surface of water in an aquarium. Goetghebuer records it from water collected in the axils of teasel leaves; Laboulbène from running sap of alder. The species was determined by

Verrall as *versicolor*, but this was doubtless a mistake, as Winnertz could hardly have omitted to notice the front tibial ring.

10. **D. versicolor** (Winn.), Goet. Smaller than the last; scutum darker, bluish tinge less obvious and markings rather different; front tibia without median dark ring; front femora usually not much darkened, so that the pre-apical pale ring is indistinct. Common. Breeds in the running sap of elms and other trees; I have also obtained it from roots of burdock (*Arctium lappa*).

Under this name I provisionally include a large number of specimens showing a good deal of variation in colour, some without blue tinge on the scutum, some with legs and scutellum largely blackish; but all with only very slight and indefinite variation in structure (antennae and hypopygium). Some of these specimens were determined by Verrall as *obscura*, Winn., and under this name the life-history of the species has been described by Keilin. It is indeed possible that *obscura* is a dark-legged form of this species, but most of our specimens (including all those bred from tree-sap) agree better with Winnertz's description of *versicolor*, and I therefore think it better to use this name for our species; specimens received from Dr. Goetghebuer show that he was dealing with the same insect. It is rather doubtful from the descriptions whether *flavifrons*, Guérin, and *hippocastani*, Mik, are specifically distinct from *versicolor*; if not, the first of these names must be adopted. Very close study of a large amount of bred material in good condition will be needed before it can be established whether we have one or several species in this group.

CULICOIDES, Latr.

(Plate XCII, figs. 15–26, wings of various species.)

General diagnosis.—Body moderately slender, not very hairy. Eyes bare. Male antennae distinctly plumose, the last three segments long. Female antennae with segments 2–9 rounded or oval, 10–14 more or less cylindrical and longer. Scutum always dull, with short hair and few or no longer bristles; humeral pits always large and distinct. Hypopygium much as in *Forcipomyia* and *Dasyhelea*. Legs slender. Femora without spines. First hind tarsal segment at least twice as long as second. Fourth tarsal segment shorter than the fifth, but rarely distinctly cordiform. Claws small and equal in both sexes. Empodium very short. Wings with distinct microtrichia over the whole surface; as a rule macrotrichia present also, if only at the tip of the wing. Costa extending beyond the middle of the wing, the two radial cells distinct and about equal in length. Cross-vein very little oblique. Median fork with distinct stalk, the branches parallel, base of lower branch often obsolete. Intercalary fork represented by a fold which runs close to and nearly parallel with M_1, the upper branch of the fork hardly distinguishable; another fold lies within the median fork, and extends from near the base of M_2 to near the tip of M_1. Cubital fork widely open, Cu_1 somewhat arched at the base. Anal vein straight. Alula fringed; squama bare.

The majority of species of this genus may be recognised by their spotted wings, although there are a few which have no spots and a few species in other genera which have quite definite wing-markings. A better diagnostic character is that to which Malloch called attention in 1915, namely the presence of conspicuous humeral pits. These pits are absent in *Dasyhelea*, the nearest relative of *Culicoides*, as well as in most other genera of the subfamily. They are present in *Ceratopogon* and most species of *Stilobezzia* and *Monohelea*, but these belong to the predaceous section of the family and have one or both of the female claws large, or the legs otherwise modified.

The genus is cosmopolitan, about 14 species having been found in Britain, these including all the bloodsucking CERATOPOGONIDAE known to occur with us. Most of our British species have been convicted of sucking human blood either here or in Belgium, the exceptions being *parroti*, *chiopterus*, *circumscriptus*, *winnertzi*, and *pictipennis*; the lack of evidence against these is probably mainly due to their comparative scarcity. Different species are troublesome in different districts; usually the worst offender (because most abundant) is either *C. obsoletus* or *C. arcuatus*, these two species being to a large extent mutually exclusive. Our species are rather easily distinguished as follows :—

1. Wings milky-white, with a deep black spot over radial cells; fourth tarsal segment cordiform; first radial cell fairly broad . . . . 2.
   Wings otherwise; fourth tarsal segment not distinctly cordiform; first radial cell quite narrow . . . . 3.
2. Thorax black, greyish only about the humeral pits . . . . *stigma*, Mg.
   Thorax grey with blackish dots and stripes . . . . *parroti*, Kieff.
3. Macrotrichia confined to the tip of the wing . . . . 4.
   Macrotrichia spread over at least half the surface of the wing . . . 5.
4. Wings of ♂ white, unmarked, of ♀ very faintly marked; wing-length 1 mm. *chiopterus*, Mg.
   Wing-markings more obvious, present in both sexes; wing-length 1·2 to 1·5 mm. . . . . *obsoletus*, Mg.
5. Wings without definite markings, at most the hair over the radial cells dark . . . . 6.
   Wings with definite (though sometimes faint) markings . . . . . 8.
6. Macrotrichia rather scanty, not darkened over radial cells; stem of median fork rather long; wing hyaline, length 1 mm. . . *minutissimus*, Zett.
   Macrotrichia denser, stem of median fork shorter . . . . 7.
7. Thorax light brownish; wing cream-coloured, length about 1·5–2 mm. *vexans*, Staeg.
   Thorax black; wing white, length 1·3 mm. . . . . . . *heliophilus*, Edw.
8. Second radial cell entirely dark . . . . 9.
   Second radial cell partly or wholly included in a pale spot . . . . 12.
9. Scutum not dotted; wings with ground-colour dark or greyish . . . 10.
   Scutum with numerous dark dots at the insertion of the hairs . . . 11.
10. Wings pale greyish, with a large whitish spot before the radial cells and another smaller one immediately beyond them; thorax unmarked *fascipennis*, Staeg.
    Wings darker, with numerous small white spots round the margin; scutum with dark markings . . . . *winnertzi*, nom. n.
11. Wings with large roundish pale spots on a dark ground-colour *circumscriptus*, Kieff.
    Wings with suffused dark markings . . . . *nubeculosus*, Mg
12. Wings with greyish ground-colour, with paler oval spots which run together to form transverse bands; thorax light brownish, unmarked *pictipennis*, Staeg.
    Wings with dark markings on a pale ground . . . . 13.
13. Wing-markings not much darker towards costa; outermost dark costal spot with its inner margin gently concave; no spot in cubital fork *arcuatus*, Winn.
    Wing-markings blacker towards costa; outermost costal spot hour-glass shaped; cubital fork usually containing a dark spot . . *pulicaris*, Zett.

1. **C. stigma** (Mg.). Knob of halteres clear yellow. The pale ring at base of each tibia is indistinct. Wing over 2 mm. Rare. Harrow Weald, Mx.;

Letchworth and Knebworth, Herts.; Bucks Mills, S. Devon (*Edwards*). Flies in May, not taken later.

2. **C. parroti**, Kieff. (Plate XCII, fig. 15.) Very similar to *stigma*, but ground-colour of scutum grey; numerous dark dots about the shoulders, and three blackish stripes. Tibiae each with a sharply defined yellow ring close to the base. Knob of halteres mainly dark, only the tip paler. Cringle Fields, Manchester (*Britten*); reared from floating green alga.

3. **C. chlopterus** (Mg.) (*amoenus*, Winn.). Wing only about 1 mm.; in ♂ uniformly whitish, or with a slight dark mark between the radial cells; in ♀ more greyish with indistinct whitish patches towards the costa, one including *r-m* and the other most of the second radial cell, the veins between these two patches dark. Rather common. Reared from running elm sap (*Saunders*). It is possibly a small, pale form of the following.

4. **C. obsoletus** (Mg.) (*varius*, Winn.; *sanguisugus*, Coq.). (Plate XCII, fig. 16.) Wing about 1·5 mm.; markings fairly distinct in ♂, more so in ♀, but not very conspicuous or sharply defined. Abundant and very troublesome, especially in south and east England. I have twice hatched examples from rather dry decaying fungi; Strobl also recorded a similar occurrence. Saunders has obtained it from sheep-dung in fields, and it will probably be found to occur in any moist decaying vegetable matter, though perhaps not in water. The N. American *C. sanguisugus* appears to be identical, according to specimens in the British Museum received from Malloch.

5. **C. minutissimus**, Zett. (*pumilus*, Winn.; ? *saltans*, Winn.). This has no special distinguishing features except its small size and rather sparse macrotrichia. Rather common. Goetghebuer records it as biting, but I have not observed it to do so.

6. **C. heliophilus**, Edw. Distinguished from *C. vexans* by its black thorax and white wings, from *C. stigma* by absence of a conspicuous black spot over the radial cells (though the hairs here are black) and from both by its much smaller size. Arran; Yorks.; Dartmoor; Dorset; probably common in hilly districts. Bites in hot sun at mid-day, instead of in late afternoon as do the other species.

7. **C. vexans** (Staeg.). (Plate XCII, fig. 17.) The hair over the radial cells is usually black, forming a more or less obvious but not conspicuous spot; frequently a band of dark hair extends below the radial cells and continues along Cu_2, and in the most strongly marked specimens there are faint traces of paler areas beyond the radial cells, over *r-m*, and in the anal cell (quite as in *C. fascipennis*). On the other hand, there is very often no dark hair on the wings at all; such specimens appear to agree with Winnertz's *cunctans*, but I do not think they constitute a distinct species. I have examined Staeger's types and find them to agree with the darker of our specimens. Common, especially in some districts (*e.g.* the western and southern outskirts of London) where it is second in numbers and troublesomeness to *C. obsoletus*.

8. **C. fascipennis** (Staeg.). Wings with a large whitish spot or abbreviated band extending from the costa over *r-m*; a small whitish spot just beyond the radial cells and sometimes just including the tip of the outer radial; radial cells darkened. These markings are not conspicuous and are best seen when the wing is viewed very obliquely with the tip nearest the lens. Thorax light brownish. Rather common; bites occasionally.

9. **C. circumscriptus**, Kieff. (*edwardsi*, Goet.). (Plate XCII, fig. 19.) Readily known by the spotted scutum and the sub-confluent round pale spots on the wings. Our specimens agree well with the descriptions and with

Goetghebuer's figure. Rare: Frinton, 1 ♀ (*Nurse*); South Kensington 1 ♀ (on window in British Museum); Dartmouth, 1 ♂ (*Edwards*). Occurs also in Palestine and Asia Minor.

10. **C. nubeculosus** (Mg.) (*puncticollis*, Bech.; *puncticollis*, Goet.; *punctaticollis*, Goet.; *riethi*, Kieff.). (Plate XCII, fig. 20.) One of our largest species; wing 2–3 mm. Wings with suffused dark markings on a pale ground, which distinguishes it at once from *C. circumscriptus*, the only other British species with a conspicuously dark-dotted scutum. Legs blackish, with conspicuous pale rings near tips of femora and near bases of tibiae. Widely spread and sometimes common, especially near coasts. Bites severely. I have obtained the larvae in liquid farmyard manure. Rieth records those of *C. riethi* (which according to specimens in the British Museum appears to be only a small form of this species) from salt water.

11. **C. pictipennis** (Staeg.) (*guttularis*, Kieff.). (Plate XCII, fig. 21.) This is not the species which Winnertz and subsequent authors have mistakenly identified as *pictipennis*. Staeger's type has no markings on the scutum and the wing-markings are altogether different from those of the species figured by Winnertz; it agrees with Kieffer's description of *guttularis*, which is probably synonymous. Rather common, but never abundant or troublesome, so far as I am aware.

12. **C. winnertzi**, nom. n. (*pictipennis*, Winn., *nec* Staeg.). (Plate XCII, fig. 18.) Very readily distinguished from all other European species by the wing-markings, but there are close allies in North America and also in tropical Africa. I have reared it from pond water in company with *C. pulicaris*.

13. **C. arcuatus** (Winn.). (Plate XCII, fig. 22.) Intermediate between *C. obsoletus* and *C. pulicaris*, being rather larger and with more distinct wing-markings than the first, smaller and less distinctly marked than the second. Scutum normally without markings; macrotrichia spread over more than half the wings as in *C. pulicaris*. Extremely abundant and annoying in all hilly districts of the west and north, where it far outnumbers the other species; scarce or absent in south-east England, where its place is taken by *C. obsoletus*.

14. **C. pulicaris** (L.). (Plate XCII, figs. 23–26.) A common species throughout the country, and very variable. The scutum is sometimes without any markings, sometimes with three small separate dark spots towards the front; sometimes with these spots much enlarged and more or less fused. The wing-markings are also very variable; most specimens can be grouped into one of four varieties, which might be regarded as separate species if it were not for the rather frequent occurrence of intermediates and for the fact that males of even the extreme forms have identical hypopygia. The typical forms of the four varieties are :—

a. (Plate XCII, fig. 23). Wings with a slight milky tinge. Outermost dark costal spot broadest *on* the fold above M_1, where it ends abruptly. Dark patches over tips of M_1 and M_2 uniform. Scutum unmarked or with small markings only. Commom.

b. (Plate XCII, fig. 24). Wings with a slight milky tinge as in the last. Outermost dark costal spot broadest *above* the fold above M_1, and thence continued more faintly as far as vein M_1. The dark patches on M_1 and M_2 include a small white spot at the tip of each of these veins. Scutal markings larger and distinct. Common. Described by Kieffer as var. *ocellaris*, but answers well to Meigen's description of *punctatus*.

c. (Plate XCII, fig. 25). Wing-markings more suffused than in the last two, and there is an additional dark cloud in cell M_1 near the base. Local.

d. (Plate XCII, fig. 26). Wing-markings similar to var. *a*, but there is no dark spot in the middle of cell Cu_1 (such as is present in the other three varieties) and the wings lack the slight milky tinge. These specimens are similar to *C. arcuatus*, but are larger; the outermost costal spot is more hour-glass shaped; and the spot in the base of the median fork is separate. Island of Arran. This is perhaps Goetghebuer's *C. impunctatus*.

In each of these varieties the dark markings vary in extent, although their arrangement is more constant. All four may occur in the same place; the four specimens figured were all taken at Brodick, Arran, on about the same day. The larvae are aquatic, occurring usually among green algae.

CERATOPOGON, Mg.

(*Psilohelea*, Kieff.; *Isohelea*, Kieff.; *Anakempia*, Kieff.; *Brachypogon*, Kieff.)

(Plate XCI, figs. 4 and 5, wings of *C. niveipennis* and *C. sociabilis*.)

The interpretation of Meigen's name *Ceratopogon* depends on the identification of the type species, *C. communis*, which, contrary to what might be supposed from its name, appears to be a rare insect. On information concerning the type supplied by Séguy, I concluded in 1920 that *C. communis* belonged to a genus distinct from any of those described by Kieffer. Subsequently a re-examination of the type by Goetghebuer showed that *C. communis* has pubescent eyes, and on this account Saunders treated it as synonymous with *Psilohelea*, the venation of the two being identical. Although Kieffer in his latest paper maintained that these genera were distinct, the characters which he gives for separating them appear trifling, and moreover he was mistaken in supposing that *C. communis* has distinct microtrichia on the wing-membrane. I therefore follow Saunders in using *Ceratopogon* in place of *Psilohelea*.

Isohelea was founded by Kieffer not on actual specimens but on Winnertz's description of *C. lacteipennis*. In Winnertz's monograph the description of *C. nitidus* follows immediately after *C. lacteipennis*, and in his original diagnosis (1919) Kieffer appears to have mixed up the characters of these two species, though he later (1925) corrected the mistake without comment. According to the description Winnertz's *lacteipennis* is probably identical with *Psilohelea sociabilis*, Goet., which differs from typical *Psilohelea* in the reduced lower branch of the media. As the other characters are in agreement, I do not regard this as sufficient to separate *Isohelea* from *Psilohelea*. *Anakempia* does not differ distinctly from *Isohelea*.

In *Brachypogon vitiosus*, as described by Winnertz and confirmed by my examination of the type in the Bonn museum, the lower branch of the media has entirely disappeared, and both radial cells are entirely obliterated. This at first sight appears a striking difference from *Isohelea*, but Kieffer has described an intermediate species (*Anakempia minima*) in which the radial cells are absent, although M_2 is partly preserved. Probably therefore *Brachypogon* might also be included in Ceratopogon.

General diagnosis.—Body rather stout and almost bare. Eyes more or less pubescent. Female antennae with segments 2-9 rounded, 10-14 not very long. Male antennae with the last three segments long. Mesonotal pits present, though sometimes very small. Scutum without long bristles. Male hypopygium not inverted; the side-pieces much swollen; ninth tergite not very large; parameres separate. Legs rather slender, without long bristles. Fourth tarsal segment short but not distinctly cordiform. Empodium very short or absent. Claws of female

all rather large, equal or not very unequal. Wings broad, milky-white, owing to the absence of microtrichia; macrotrichia absent or reduced to a few round the apical margin. Costa reaching somewhat or considerably beyond the middle. Two radial cells normally present, about equal in size. Cross-vein not very oblique. Intercalary fork indistinct. Median fork with rather long stem, or lower branch widely interrupted; no fold between the branches. Anal vein slightly swollen and bent in the middle, but no distinct fold arising from the bend. Alula and squama bare.

The genus includes a small number of European species of similar appearance. The females are normally predaceous on CHIRONOMIDAE, but may also be found on flowers. They are not known to suck blood. The males of some species (*sociabilis* and *nitidulus*) fly in swarms in hot sun. Three subgenera may be recognised, according to the condition of the media :—

M_2 complete or only narrowly interrupted at the base *Ceratopogon* s. str (= *Psilohelea*).
M_2 with about the basal half missing . . . . . *Isohelea* (= *Anakempia*).
M_2 entirely absent . . . . *Brachypogon* (not British).

Subgenus **Ceratopogon** s. str.

M_2 complete or only narrowly interrupted at base (rather variable individually). Costa extending to nearly two-thirds; both radial cells distinct and longer than broad. Scutellum with 6–8 longish bristles and a number of short hairs. Humeral pits distinct. Wing-length 1·5–2·5 mm.

We have three British species :—

1. C. **niveipennis**, Mg. (*candidatus*, Winn.). Scutum dull black; pits large, transversely oval. Female claws toothed on the inner side; last antennal segment not much longer than the penultimate. Eyes distinctly pubescent. Wing-length 2–2·5 mm. Cell M_1 somewhat widened at tip. Rather common.

2. C. **crassinervis** (Goet.) (?). Similar to the last, but scutum distinctly shining and eyes almost bare, with very fine and short pubescence in parts only. Humeral pits rather smaller than in *niveipennis*; last antennal segment nearly twice as long as the penultimate. Wing-length about 1·5 mm. Snailbeach, Salop., 1 ♀ (*Edwards*). Differs from Goetghebuer's type (described as a *Stilobezzia*) in having M_2 much more distinctly curved down at the tip.

3. C. **lacteipennis**, Zett. (*edentata*, Edw.). Scutum shining, pits small and round. Female claws simple; last antennal segment not much longer than the penultimate. Eyes with very fine pubescence (I described them as bare, but this was a mistake). Branches of *M* evenly divergent. Wing not quite so milky-looking as in the other two, bluish by transmitted light; a few macrotrichia on the membrane round the tip; length about 1·5 mm. Arran, 1 ♀ (*Edwards*). This is very close to Meigen's *communis*, which differs chiefly in having the mesonotum dull.

Subgenus **Isohelea**, Kieff.

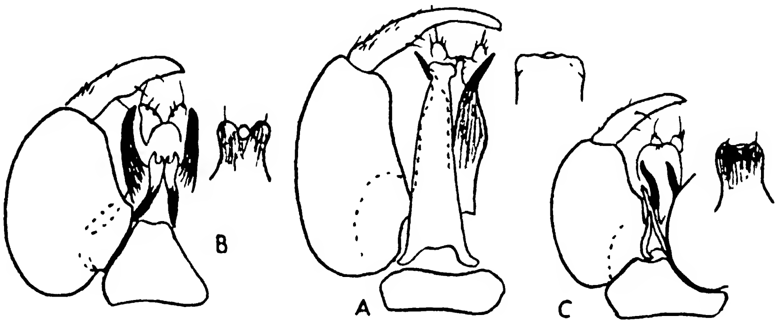
M_2 widely interrupted at the base, from one-third (♂) to one-half or more (♀) being missing. Costa not reaching much beyond middle, radial cells little if any longer than broad (absent in *minima*, Kieff.). Scutellum with 4 bristles only. Humeral pits minute. Wing-length barely 1 mm.

1. C. **sociabilis** (Goet.) (*lacteipennis*, Winn. *nec* Zett.). (Text-fig. 1*a*.) Scutum somewhat shining, but with fine grey dusting, especially towards the

sides, so that when seen from in front it appears almost dull. Veins forming the radial cells pale. Wing-length 1–1·2 mm. I. of Arran; Whernside and Skipwith, Yorks. (*Edwards*); Penzance (*Verrall*). Probably common in the north and west. Our specimens differ from Goetghebuer's and Winnertz's descriptions in having the claws of the female distinctly unequal, both rather large. The hypopygium (text-fig. 1*a*) corresponds with Goetghebuer's figure, and I therefore adopt his name. The specimens from Penzance were recorded by Verrall as *C. forcipatus*, Winn., but that species is an *Atrichopogon*.

2. **C. nitidula** (Edw.). (Text-fig. 1*b*.) Scutum brightly shining, without grey dusting. Veins bordering the radial cells very slightly darkened. Hypopygium (text-fig. 1*b*) differing from that of the last species. Wing-length barely 1 mm. I. of Arran; Gidleigh, S. Devon; Little Whernside, Yorks. (*Edwards*).

3. **C. perpusilla** (Edw.). (Text-fig. 1*c*.) Scutum brightly shining, without grey dusting. Veins bordering the radial cells dark brown. Hypopygium



Text-fig. 1.—Hypopygium from beneath, also tip of ninth tergite, of (A) *Ceratopogon sociabilis* (Goet.); (B) *C. nitidula* (Edw.); (C) *C. perpusilla* (Edw.).

(text-fig. 1*c*) more resembling that of *sociabilis* than *nitidula*, but side-pieces less swollen, etc. Wing-length under 1 mm. I. of Arran; Gidleigh, S. Devon (*Edwards*).

Serromyia (Mg.), Kieff.

(*Prionomyia*, Steph.; *Ceratolophus*, Kieff.; *Johannseniella*, Kieff.)

(Plate XCI, fig. 6, wing of *S. morio*.)

As the same type-species has been designated for all the above genera, they are clearly synonymous. No description was published by Meigen in connection with the name *Serromyia*, and it might very well be argued that *Prionomyia* has precedence over *Serromyia*, the first definition of which was due to Kieffer. However, the name *Serromyia* is now in common use, and it will be well to follow Kieffer in considering that its original publication in connection with *femorata* renders it a valid name.

General diagnosis.—Body rather slender and bare. Eyes bare. Female antennae with the last five segments long and cylindrical. Male antennae with distinct plumes. Scutum with fine bristles only, arranged chiefly in dorso-central and acrostichal series. No mesonotal pits. Front and middle legs slender, without distinct spines; fourth tarsal segment cordiform; claws moderate in size and

about equal. Hind legs with the femur very much swollen in both sexes, and with numerous spinules beneath; tibia not distinctly swollen, curved at base; fourth tarsal segment cylindrical; claws of female usually very unequal, one being very long. No empodium. Wings with fine macrotrichia, and occasionally a few microtrichia round the tip. Costa extending to about two-thirds of the wing-length. Both radial cells distinct, second not very much longer than the first. Cross-vein almost vertical. Intercalary fork not distinguishable, nor any fold below M_1. Median fork shortly stalked or just sessile, M_2 not interrupted at base. Anal vein bent just beyond the middle, an indistinct fold arising from the bend. No hairs on alula.

A small and rather well-defined genus of which we have three British species. The females are predaceous on other insects; the males of *S. femorata* fly in swarms at mid-day.

S. femorata (Fab.). Scutum shining black, with a slight sub-metallic greenish tinge. Dorso-central and acrostichal hairs in rather irregular double rows. Veins forming the radial cells pale. No macrotrichia on membrane round tip of wing. Larger claw of hind feet of ♀ very long. Common, especially in mountainous districts.

S. morio (Fab.). Thorax brightly shining black, without greenish tinge. Dorso-central and acrostichal hairs less numerous, and in single rows. Veins forming the radial cells dark. Usually a few macrotrichia on membrane round the tip of the wing. Larger claw of hind feet of ♀ very long. Rather common.

S. nitens, Goet. Resembles *S. morio* in everything except the hind claws of the ♀, which are both small. Baldock, Herts., 1 ♀ (*Edwards*).

MONOHELEA, Kieff.

(Plate XCI, fig. 7, wing of *M. tessellata.*)

General diagnosis.—Body rather short, not very hairy. Eyes bare. Mesonotal pits present but very small. Front and middle legs unmodified, the fourth tarsal segment short but cylindrical and the claws rather small and equal in both sexes. Femora and tibiae of hind legs both distinctly thickened, but the femora without spines; first tarsal segment with a strong spine at the tip; fourth cylindrical. In the ♀ the hind-legs have one very large claw and one small one. No empodium. Wings with fine microtrichia, but without macrotrichia, or only a very few at the extreme tip. Costa extending well beyond the middle. Two radial cells well formed, second distinctly or considerably longer than the first. Intercalary fork fairly distinct. Cross-vein vertical. Median fork with short stem, M_2 not interrupted at base. Anal vein slightly thickened in the middle, but no distinct fold arising at the thickening. No hairs on alula (in the type).

Only two European species are known, both of which have been found in Britain. Nothing has been recorded concerning their habits, but the females are probably predaceous like those of related genera. The genus is evidently closely related to *Serromyia.*

M. tessellata (Zett.) (*illustris*, Winn.). Scutum dull greyish with numerous dark dots and other markings. Scutellum with 4 bristles. Second hind tarsal segment with a pair of apical spines. Wings with elaborate dark markings; second radial cell much longer than the first. Oxford (*Hamm*); New Forest (*Sharp*). This species has representative forms in various parts of the tropics, one of which is the type of the genus.

M. calcarata, Goet. Scutum without markings. Scutellum with 8 bristles. Second hind tarsal segment without spines. Wings unmarked; second radial cell only a little longer than the first.

I have seen 1 ♂ from the New Forest (*Sharp*) which I identify with some hesitation as *M. calcarata*; its hypopygium agrees well with Goetghebuer's figure, but the following points are at variance with his description: Scutum almost dull, like the abdomen. Hind femora and tibiae black, as in the last tarsal segment on all the legs; first segment of front tarsus with 4 spines, of hind tarsus with 3 (not 3 and 2 respectively); 4th tarsal segment more produced below. Costa reaching just beyond the base of the intercalary fork. Wings with a few macrotrichia round the tip; alula fringed, as in *Stilobezzia*.

SCHIZOHELEA, Kieff.

(Plate XCI, fig. 8, wing of *S. leucopeza*.)

This genus is closely related to *Monohelea*, from which it differs mainly in having M_2 broadly interrupted at the base; apart from this, there are no spines on the basal segments of the tarsi, and the mesonotal pits are scarcely distinguishable.

Kieffer defined the genus as having the median fork very broadly sessile, the base of M_2 being nearer to the base of the wing than to *r-m*. This, however, is not the case in any of my specimens. There is indeed a fold which extends from M_2 to the position indicated by Kieffer, but there is no trace of a vein in this fold, and I do not consider that it represents the lost portion of M_2 here any more than it does in some other related genera in which it may be seen. Probably *Schizohelea* has been derived from an ancestor with a shortly stalked median fork such as *Monohelea*, and it is rather doubtful if it is worth while to keep the two genera separate. Should they be united the older name *Schizohelea* must be adopted.

Only a single species is known.

S. leucopeza (Mg.) (*copiosa*, Winn.). A small species, brightly shining black, only the tarsi and halteres whitish. Common, especially in the west and north. Often abundant on flowers, but whether there for the purpose of obtaining honey or pollen or in order to prey on other small insects has not been ascertained.

STILOBEZZIA, Kieff.

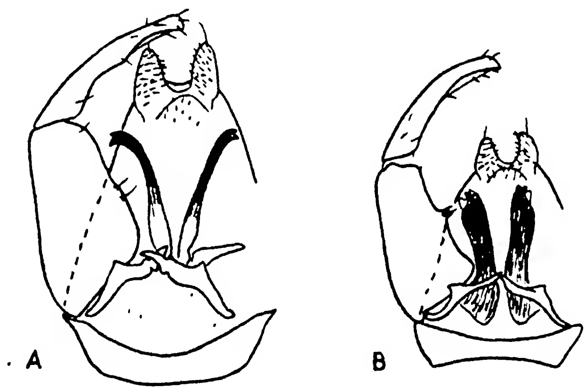
(Plate XCI, fig. 9, wing of *S. gracilis*.)

General diagnosis.—Body rather slender and nearly bare. Eyes bare. Female antennae with segments 2 9 oval, 10–14 long and cylindrical. Male antennae with well-developed plumes. Mesonotal pits present, but usually very inconspicuous. Scutum with few or no long bristles. Male hypopygium not very large. Legs all slender, femora without spines. Fourth tarsal segment cordiform, fifth not enlarged. Claws of female large and very unequal on all the legs. Empodium absent. Wings rather long; surface with distinct microtrichia, and usually with some macrotrichia towards the tip. Costa extending to two-thirds of the wing-length, or more. Both radial cells distinctly formed, second considerably longer than the first. Intercalary fork rather distinct. Cross-vein not very oblique, and placed near middle of wing. No fold in median fork, which has a long stem; M_2 not interrupted at the base; anal vein straight, not swollen in the middle. A row of hairs on the alula.

A small but nearly cosmopolitan genus rather easily distinguished by the long stem of the median fork; differs from *Ceratopogon* in the distinct microtrichia of the wing-membrane, the longer second radial cell, etc. The females are predaceous on other insects, thus resembling those of *Palpomyia* and *Bezzia* in habits. We have four British species.

S. gracilis (Hal.). Scutum shining black; scutellum and a large part of the pleurae yellow; abdomen blackish; legs largely yellow, tip of hind femur broadly dark, also the whole of the hind tibia. Macrotrichia numerous in cells R_5 and M_1, also a few in cell M_2. Scutellum with numerous bristles. Common.

S. ochracea (Winn.) (*scutellata*, Goet.). (Text-fig. 2*b*.) Almost entirely ochreous; scutum quite dull, and more or less darkened, especially in the ♂. Scape of antenna and back of head darkened. Dorso-central hairs rather long. Scutellum with four bristles, sometimes an extra one in the middle. First abdominal tergite with about 6–10 hairs on each side (more in ♂ than in ♀).



TEXT-FIG. 2.—Hypopygium from beneath, of (A) *Stilobezzia lutacea*, sp. n.; (B) *S. ochracea* (Winn.).

Hypopygium (text-fig. 2*b*) with the parameres stout and straight; side-piece with a pair of small papillae in the middle of the inner side. Hairs on hind tibia rather long and fine. Macrotrichia in ♂ wing numerous in cells R_5 and M_1; in ♀ wing numerous also at tip of cell M_2. Wing-length 1·5–2 mm. Rather common in the west and north.

S. lutacea, sp. n. (Text-fig. 2*a*.) An almost uniformly ochreous species, resembling *S. ochracea*, but differing in many details, as follows:—Scape of antennae pale in ♀, back of head pale in both sexes; ♀ antennae rather longer, the third segment cylindrical instead of oval. Dorso-central hairs of scutum shorter. Scutellum with 6–8 bristles, sometimes with an additional one in the middle. First abdominal tergite with about 15 hairs on each side. Hypopygium (text-fig. 2*a*) with the parameres slender, curved, bifid at tip; side-pieces without papillae. Hairs on hind tibia rather shorter and stronger. Macrotrichia in ♂ wing very few in number and present only in cell R_5; in ♀ wing more numerous and present in cells R_5 and M_1, very few or none in cell M_2. Wing-length 2·5 mm. Porthcawl, Glamorgan (*Yerbury*).

S. flavirostris (Winn.). Differs from the other three species in having no macrotrichia on the wing-membrane. Body shining black, except the first abdominal segment, which is greenish. Mouth-parts, basal half of antennae,

and legs pale yellow, the four posterior femora black at the tip. Scutellum with four bristles, the lateral pair small. Ickleford, Herts. (*Edwards*). Cambridge (*Jenkinson*). The resting position is unique among British Ceratopogonines, the wings being held divergent at an angle of about 45° with the body. In the specimen from Cambridge the posterior femora are more extensively black, only the base being yellow.

NEUROHELEA, Kieff.

(Plate XCI, fig. 10, wing of *N. luteitarsis*.)

Characters as in *Palpomyia*, with the following exceptions :—Scutum without trace of anterior tubercle. Abdomen of female without eversible glands. All femora slender and unarmed. Last segment of front tarsi somewhat swollen in both sexes. Costa extending much beyond R_5. Median fork only just sessile or with very short stem.

Only one species is known; on account of the strongly produced costa it is sharply distinguished from all other members of the subfamily in Britain.

N. luteitarsis (Mg.) (*subsessilis*, Goet.). A small shining black species with pale tarsi; wings unmarked. Rather common in the west and north.

CLINOHELEA, Kieff.

(Plate XCI, fig. 11, wing of *C. unimaculata*.)

Characters as in *Palpomyia*, with the following exceptions :—Scutum without trace of anterior tubercle. Abdomen of female without eversible glands. All femora slender and unarmed. Last segment of front tarsi much swollen in both sexes. Fourth tarsal segment on the four posterior legs of the female deeply bilobed beneath, each lobe terminating in a strong blunt spine; claws of the four posterior legs of the female very unequal. No distinct fold arising from the bend in the anal vein.

Only one species is known in Europe.

C. unimaculata, Mcq. (*maculipes*, Mg.; *variegata*, Winn.). A shining black species, with partly yellow legs, the last front tarsal segment pure white in the middle. Wings with a blackish cloud over the first radial cell. Castle Howard and Gormire, Yorks (*Edwards*).

JOHANNSENOMYIA, Mall.

(*Johanndseniella* auct., partim; *Sphaeromias*, Kieff. *nec* Curt.)

Characters as in *Palpomyia*, with the following exceptions :—Scutum without any trace of anterior spine or tubercle. Abdomen of female without eversible glands. All femora slender and unarmed. Last segment of female tarsi with two rows of stout blunt-tipped bristles beneath. Female claws with a large tooth on the outer side at the base.

The females are predaceous, and are believed to devour their own males after copulation, as the male hypopygium is frequently found attached to the end of the abdomen of the female. About half a dozen European species are known, of which three have been found in Britain.

J. nitida (Mcq.). A shining black insect; abdomen either practically all black, or with the second segment more or less yellow. Hind tibiae all black in both sexes; mid and hind femora broadly black at the tip. In the female,

the face and scape are usually reddish, second antennal segment pale with black tip, segments 10–14 as long as 2–9 together; first two segments of hind tarsi together about as long as the tibia, pale except for narrow dark tips. Sometimes the antennae and face are wholly black. Last segment of ♂ antennae four times as long as segment 12. Male hypopygium very long, claspers short, less than one-third as long as the side-pieces. Wing-length 2·2 mm. (♂) or 3·5 mm. (♀). Locally common.

J. inermis (Kieff.) (*kiefferi*, Goet.). Very much like *J. nitida*, but rather larger. Hind tibia of ♀ mainly yellow, only the tip black, base also darkened; hind femora with dark pre-apical ring; mid femora practically all yellow. Hind tibia in the ♂ darker, but not wholly black. Front tibiae yellow in both sexes. Segment 14 of ♂ antennae 4 times as long as segment 12. Hypopygium of ♂ small; claspers more than half as long as the side-pieces, with a conical tooth at the tip. Wing-length 2·8 mm. (♂) or 4·5 mm. (♀). Aldenham, Herts. (*L. Armstrong*); Staines, Middlesex (*Austen*).

J. setigera (Lw.) (*silvicola*, Goet.). ♂. Similar to *J. nitida*, but all tibiae and hind tarsi of ♂ all black; femora also more extensively black, on the four posterior legs less than the basal half of the femora is yellow; hind tibiae with a dorsal row of bristly hairs, which are absent in the last two species. Segment 14 of ♂ antenna only 3 times as long as segment 12. Hypopygium small and short, claspers pointed, without tooth at tip. Cardington, Beds., 1 ♂ (*Edwards*).—♀. Scape orange; flagellum wholly black, shorter than in *J. nitida*, segments 10–14 being distinctly shorter than 2–9 together. First two abdominal segments almost all yellow, the rest dark brownish. Mid and hind femora broadly black at the tip. Hind tibiae dark brownish with black tips, and with a dorsal row of bristly hairs, rather more numerous than in the ♂. First two segments of hind tarsi together considerably shorter than the tibia, the second segment all dark. Several females in the Clifton collection in the British Museum; locality uncertain. They agree with Loew's description and are almost certainly the females of *J. silvicola*.

DICROBEZZIA, Kieff.

(Plate XCI, fig. 13, wing of *D. venusta*.)

Characters of *Palpomyia*, with the following exceptions:—Scutum without trace of median anterior tubercle; a number of short scattered bristles present in addition to the usual fine pubescence. Abdomen of female without eversible glands. All femora slender and unarmed. Claws of female large and bifid, the last tarsal segment with blunt spines beneath. Only one radial cell present, R_2 being absent. Costa in female reaching almost to the tip of the wing (in male much shorter).

In the tarsal structure of the female this genus is very similar to *Johannsenomyia*; it seems to bear the same relation to *Bezzia* as *Johannsenomyia* does to *Palpomyia*. The chief distinction from *Bezzia*, apart from the striking differences in the female, is in the presence of scutal bristles; in this respect it differs also from *Johannsenomyia*, which I regard as its nearest relative.

There is one European species; its feeding habits have not been noted, but the females are doubtless predaceous.

D. venusta (Mg.) (*varipes*, Steph. MS.; *mundus*, Lw.; ♂ *inflata*, Winn.). Thorax shining black; abdomen in female either entirely membranous and pale yellow, or (var. *concinna*, Mg.) with some of the tergites chitinised and

blackish, the number of these being variable (4 and 5, 3–5, 2–5 or 1–5). Halteres yellow; legs yellow, femora and tibiae broadly black at tips; hind tibiae with a black band before the middle. The sexual difference in venation is remarkable, and it is surprising that Kieffer should have described the male without noting this. Locally common.

SPHAEROMIAS, Curt.

(*Xylocrypta*, Kieff.)

Characters of *Palpomyia*, with the following exceptions:—Eyes nearly touching. Scutum without anterior tubercle. Abdomen of female without eversible glands. Femoral spines more numerous, but smaller and inconspicuous. Fourth tarsal segment short but almost cylindrical, not distinctly cordiform or bilobed beneath. Fifth tarsal segment of female armed with blunt spines beneath, claws large. Body stouter. Male antennae short, without plumes. Fringe of hind margin of wing continued along the ill-defined alula as far as the squama.

As I employ the name *Sphaeromias* in a different sense from that in which it has lately been used by Kieffer, an explanation is necessary. The name was introduced by Stephens without description, three manuscript species being assigned to it. The description published later by Curtis was based on examples of one of these species (*albomarginatus*) supplied by Stephens; this (and not *varipes*, Stephens MS.) is therefore the type. Curtis' description of *albomarginatus* corresponds with *fasciatus*, Mg., except that he does not mention femoral spines. The omission led Kieffer to assume that *Sphaeromias* was different from his *Xylocrypta*, but there is no doubt that Curtis simply overlooked the spines, which as stated above are small and inconspicuous. Stephens' collection in the British Museum contains specimens under his three names. Of these *albomarginatus* is typical *fasciatus*; *annulitarsis* is also *fasciatus*, the specimens being immature and the black bands of the abdomen therefore not showing; *varipes* is *Dicrobezzia venusta*, and therefore is excluded from consideration as it does not agree with the generic diagnosis.

The genus includes the largest species of the family; two occur in Britain, and there are perhaps two or three others in Europe, but they have not yet been satisfactorily distinguished.

S. fasciatus (Mg.) (*albomarginatus*, Steph.; *procerus*, Zett.). Male brownish, abdomen without conspicuous markings. Female thorax greyish, with brownish stripes, the middle one not distinctly divided behind; abdomen whitish; with black bands or spots at the bases of the tergites, these markings being variable. Front femora with about 25 small spines, mid and hind femora each with about 10. Female claws with tooth on inner side near base. Hind femora largely dark, but pale at the tip. Hair on thorax and legs very short and inconspicuous. Wings hyaline, not at all milky. There are specimens without data in various old collections; the only recent records from Britain are Frinton-on-Sea (*Collin*) and Yarnton, Oxford (*Hamm*). The males described by Haliday as *pictus* most probably belong to this species.

S. candidatus (Lw.). Female thorax reddish, but rather densely covered with whitish dust, and also with numerous distinct whitish hairs; stripes more distinct than in *fasciatus*, the middle pair more divergent behind. Abdomen marked much as in *fasciatus*. Legs mainly yellowish, with conspicuous whitish hair; mid and hind femora with the tips somewhat darkened, tips of tibiae black; claws without tooth. Wings milky white, the anterior veins

hardly darkened. One female in Stephens' collection, without data; the British Museum also possesses a continental specimen from Ruthé. Both are larger than Loew's type (wing-length 4·5 mm.).

This is perhaps only a pale variety of *pictus*, Mg. (*elegans*, Winn.), which according to the descriptions (confirmed by a continental specimen in the British Museum) differs in the darker thorax, abdomen, and legs; the femora and tibiae are mostly blackish, the front tibia having a narrow and rather indistinct yellow ring near the tip.

PALPOMYIA (Mg.), Kieff.

(Incl. *Heteromyia*, Say.)

(Plate XCI, fig. 12, wing of *P. semifumosa*.)

General diagnosis.—Body rather slender and almost bare. Eyes bare and usually well separated. Palpi slender, the second segment not enlarged. Antennae of female with segments 2–9 oval, verticils not very dense, 10–14 cylindrical and usually long. Antennae of male with the plumes inconspicuous, sometimes practically absent. Scutum in most if not all species with a small tubercle or spine (sometimes minute) in the middle of the front margin; surface almost uniformly covered with fine hairs only. Lateral piece of scutum (paratergite of Crampton) broad. Posterior pronotal plate large and including the prothoracic spiracle. Pleurae almost entirely chitinised, the anepisternal cleft narrow and oblique. Abdomen of female in nearly all species with pairs of eversible glands between segments 7 and 8, usually also between some of the other segments; when these glands are present the corresponding tergites have pairs of long spine-like internal projections from their anterior margins. Hypopygium of male partially or completely inverted, the anal part being ventrally placed (the inversion no doubt taking place after emergence from the pupa, as in other similar cases). Ninth tergite rather small. Parameres always fused into a single median structure with rounded tip. Cerci well developed. Front femora more or less thickened and with at least a few spines beneath. Femora and tibiae of the posterior legs slender, the femora sometimes with a few slender spines. Fourth tarsal segment cordiform or bilobed beneath, but unarmed. Fifth tarsal segment of female either unarmed or with a few slender, curved and pointed spines; claws of moderate size, equal, with or without a small tooth on the inner side near the base. Wings rather narrow; surface with fine microtrichia but without macrotrichia. Costa extending to two-thirds of the wing-length, or more. Two radial cells well formed, the second much longer than the first. No intercalary fork. Median fork rather broadly sessile, without a fold between the branches. Cross-vein vertical or nearly so. Anal vein bent upwards near the middle, a curved fold arising from the bend, so that the vein appears forked (the fold is not visible by transmitted light). Anal lobe not well marked. Alula absent; the short piece of wing-margin between anal lobe and squama without fringe.

Palpomyia is a cosmopolitan genus with numerous species, about 15 of which are found in Britain. It is distinguished from all the related genera except *Bezzia* by the remarkable eversible abdominal glands of the females; these glands, however, are not universally present, being absent in *P. nigripes* and one or two other species. First noted by me in 1920, they have since been observed by Hoffman in some American species of the genus. I would now point out that the presence, number and size of these glands is correlated with skeletal structures in the female abdomen: for each pair of glands there is a pair of chitinous internal projections extending from the base of the tergite towards the base of the abdomen, which apparently act as supports for the

glands when they are retracted. The largest pair of glands is always that between the seventh and eighth tergites, and accordingly the longest pair of chitinous rods is that at the base of the seventh sternite; the rods on tergites 6, 5, 4 and 3 (when present) are progressively smaller, as are the glands at the apices of these segments.

The females of this genus are predaceous on other insects, especially CHIRONOMIDAE. In some cases they have been observed flying in swarms with everted glands, but the males of at least some species also swarm, the time of swarming usually being just before sunset. Except in the species without abdominal glands the female is larger than the male.

The British species fall into three rather well-marked groups :—

A. Front femora slightly swollen, with 4–6 spines, the other femora unarmed.

B. Front femora more swollen, with 15–18 spines, the others unarmed.

C. All femora with one or more spines.

GROUP A.

Front femora only slightly swollen, with 4–6 strong spines beneath, and sometimes a few very small ones in addition near the tip. Mid and hind femora without spines. Claws of female without tooth and usually divergent.

This group includes *P. flavipes* (Mg.) (the genotype) and a number of related species. They are all shining black insects, with at least the knob of the halteres black; the number of abdominal glands in the female is variable, and in one or two species they are absent. One or two of the spermathecae are quite large; a third is sometimes present, but is variable in size even in one species.

Seven or eight fairly distinct British species have been recognised; they may be separated as follows :—

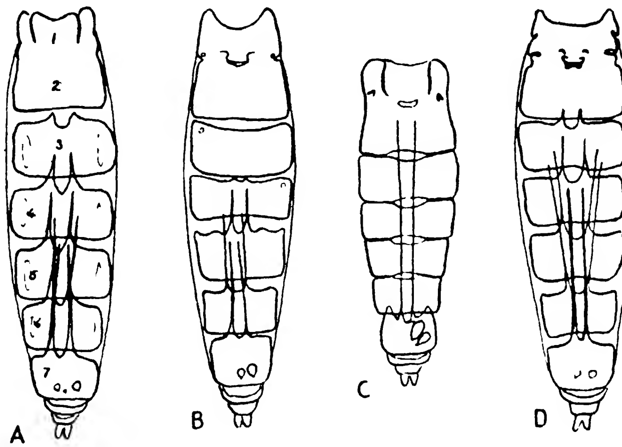
1.	Femora at least partly yellow	2.
	Legs practically all black	*nigripes*, Mg.
2.	Front femora with 6–8 spines	3.
	Front femora with 4–5 spines	7.
3.	Coxae all yellowish; female wings with dark tip	*praeusta*, Lw.
	Posterior coxae black	4.
4.	Wings with the outer half more or less smoky, contrasting with the yellowish or hyaline base	5.
	Wing almost uniformly clear	6.
5.	Tip of hind femur broadly black; tibia black	*semifumosa*, Goet.
	Tip of hind femur narrowly black, tibia mainly yellow .	*nemorivaga*, Goet.
6.	Hind femur with the apical fourth to half black	*flavipes*, Mg.
	Hind femur yellow, with a dark mark beneath near the tip . . .	sp. indet.
7.	Hind femora all yellow	*luteifemorata*, sp. n.
	Hind femora more than half black	*quadrispinosa*, Goet.

1. **P. semifumosa**, Goet. (*brachialis*, Edw., *nec* Hal.; *hortulana*, Goet., *nec* Mg.). (Text-fig. 3*a*.) Abdomen of male with the first two segments, of female with the first and the base of the second segment yellow. Hypopygium as in *P. flavipes*, except that the clasper is not hooked at the tip. Glands of female orange-red in colour, the last pair very long and forked almost from the base into two nearly equal branches, the three other pairs short and simple. Hind femur with about the apical third or fourth black; hind tibia practically all blackish. Wings of male slightly smoky on the apical half, the darkening

extending up to or just beyond the cross-vein; female wings darker, the darkening also extending further, base yellowish up to middle of basal cell. Wing-length ♂ 2·5–3, ♀ about 3·5 mm. Common in hilly districts.

This is the species the habits of which I described in 1920 under the name *brachialis*. Some points in Haliday's description, however (*e.g.* his description of the male antennae, and the statement that the front femora are stout with 6–10 spines, and the hind tibiae are " almost black at the tip "), do not fit the present species at all well. It will be better therefore to use the name *semifumosa*, the identity of which with our species has been confirmed by Dr. Goetghebuer after comparison of specimens; in his description he has apparently overlooked the fact that the smoky tinge is more extensive in the female wing than in the male.

2. **P. nemorivaga**, Goet. (? *brachialis*, Hal.). Resembles *P. semifumosa* in



TEXT-FIG. 3.—Diagrams of female abdomen showing gland-rods and spermathecae:

(A) *Palpomyia semifumosa*, Goet.; (B) *P. lineata* (Mg.); (C) *Bezzia flavicornis* (Staeg.); (D) *B. solstitialis*, Winn.

having the outer half of the wing somewhat smoky, but the colour is not so dark and does not extend beyond the cross-vein in either sex; the clear basal half has hardly any yellow tinge. Antennae of male practically devoid of plumes, the terminal segments longer than in *P. semifumosa*. Abdomen of male usually with the first three or four segments entirely yellow; female usually with two segments yellow, but in some specimens it is entirely black dorsally. Last pair of glands not forked and paler in colour. Legs mainly bright yellow, the middle and hind femora only narrowly black at the tip; hind tibiae in most specimens also mainly yellow, blackish towards the tip and also sometimes towards the base. Spines of front femora stronger than in *P. semifumosa*, and in addition to the larger ones there is a group of very small ones close to the tip. Wing-length ♂ 1·5–2, ♀ about 2·5 mm. Rather common.

Examples of this species are in the Verrall collection determined as *brachialis*, Hal., and it is quite possible that this determination is correct, although Haliday's description of the male indicates a larger insect with a less extensively yellow abdomen. Specimens which I sent to Dr. Goetghebuer were

identified by him as *P. nemorivaga*, with the description of which they agree in most respects; he does not mention the smoky outer half of the wing, but his types may have been faded.

3. **P. praeusta** (Lw.) (*apicalis*, Strobl; *schineri*, Goet.). This has been treated as a variety of *P. flavipes*, but it is quite distinct. The blackish tip of the wing, which is its most conspicuous feature (extending back as far as the tip of the second radial cell, or a little farther), is present only in the female. The male has the wing clear (only one whole specimen examined; it was identified by comparison with a detached hypopygium found fixed to the end of the body of a female). The following are the differences from *P. flavipes* :—

Coxae all yellowish in both sexes; the four posterior femora only narrowly black at the tips; hind tibiae usually with a broad though ill-defined brown ring beyond the middle, sometimes all black. Scape of female antennae reddish. Abdomen of male with very little yellow at the base, that of the female usually without any. Male hypopygium with the fused parameres stouter, not clubbed at the tip. Wings of female narrower. Abdomen of female with three pairs of glands only, these being smaller than in *P. flavipes*; gland-rods of seventh tergite only reaching back to the base of the sixth. S. Devon; Shropshire; E. Yorks. Probably common all over the west country.

4. **P. flavipes** (Mg.) (*hortulana*, Mg., *teste* Goet.). Front coxae a little yellowish, the posterior pairs black. Four posterior femora broadly black at the tips, this colour occupying from one-fourth to one-half the length of each femur. Hind tibiae normally all black; in pale specimens they may be brownish with black tips, but not darkened towards the base. Front femora with 5–7 spines. Scutum with two nearly bare stripes between the acrostichal and dorso-central stripes of microscopic pubescence. Second abdominal tergite mainly yellow, though darkened at the sides. Tip of wing sometimes very indistinctly darkened. Male hypopygium with the internal organ formed of the fused parameres rather slender, knobbed at tip. Female abdomen normally with four pairs of glands, though the fourth pair is small; gland-rods of seventh tergite reaching more than half-way across the fifth segment, sometimes as far as its base. (One of eight females mounted has no gland-rods on any segment, but shows no other differences from typical *flavipes* and is therefore regarded as an abnormal individual.) Normally two large spermathecae (one specimen has three). Common.

5. **P.** sp. indet. Similar to *P. flavipes*, but legs paler, hind femora pale to the tip on the upper side, with a dark mark beneath near the tip. New Forest, 1 ♀ (*Sharp*).

6. **P. quadrispinosa**, Goet. Coxae black. Middle and hind femora with more than the end half black. Front femora with four spines. Microscopic pubescence of scutum quite uniform. Abdomen all black; three pairs of gland-rods, the third quite short, the first extending less than half-way across the fifth segment. Antennae a little shorter than in *P. flavipes*. According to Goetghebuer this has the cross-vein placed well before the middle of the wing, but in our specimens it is close to the middle as in *P. flavipes*. Lochinver, Sutherland (*Yerbury*); Melkinthorpe, Westmorland (*Britten*); Austwick, Yorks. (*Cheetham*).

7. **P. luteifemorata**, sp. n. ♀. Allied to *P. flavipes*, and like it with practically clear wings, but differs as follows :—Antennae distinctly shorter, the ninth segment barely twice instead of fully three times as long as broad. Scutum with the microscopic pubescence quite uniform. Abdomen brownish, not distinctly yellow at the base; five pairs of gland-rods, a short additional

pair being present at the base of tergite 3; the long first pair reaching to the middle of the fourth segment. All femora entirely yellow, also the front and middle tibiae; hind tibiae and tarsi black. Front femora with 4–5 spines. Wing-length 3 mm. (*P. flavipes* ♀ is 3·5–4·5 mm.).—♂ (association with ♀ not positively established): colour much as in the ♀, but hind femora somewhat darkened for some distance before the tip, the tip itself pale. Hypopygium almost the same as in *P. flavipes*. Staines, Middlesex, 28–29.vi.1898, "dancing in the air over the Thames" (*Austen*); 8 ♀ including type. Cambridge, 1 ♂ 1 ♀ (*Jenkinson*). Lake Windermere, 1 ♂ (*Edwards*).

8. **P. nigripes** (Mg.). Entirely black, except that the front femora and all the tarsi are usually brownish. Wings clear, except that the costal and radial cells of the female are more or less smoky. Female abdomen without any glands or gland-rods; two rather large spermathecae. Male not much smaller than the female; hypopygium quite different from the other species of this group: claspers large, longer than the side-pieces; fused parameres forming a large oval structure; no aedeagus. Rather common.

Group B.

Front femora rather conspicuously swollen, with not less than 10, usually 15–18 spines in a patch beneath; front tibiae often curved to fit over the femur in repose. Middle and hind femora without spines, or at most (as sometimes in *armipes*) one or two fine ones on hind femora. Claws of female placed rather close together and with a small tooth on the inner side near the base.

This group corresponds more or less to the genus *Heteromyia*, Say, as understood by Malloch; I do not, however, see any reason for separating it from *Palpomyia*. All the British species except *grossipes* have yellow halteres; they all have two spermathecae which are rather small and about equal in size. The number of abdominal glands is variable.

1. **P. distincta** (Hal.). Scutum mostly shining black; scutellum yellow in the female, dark brownish in the male; abdomen yellow at the base, tergites 3–7 black; femora largely yellow, the posterior pairs with about the apical fourth black.

I provisionally refer to *P. distincta* all female specimens of this group in which the scutellum is yellow and the abdomen mainly black above. These, however, exhibit considerable variation in other respects and it is probable that two or more distinct species have been classed together. The following forms are represented in the British Museum collection:—

(*a*) Scape black, or at most a little reddish beneath. Face reddish or brown. Anterior part of pleurae reddish-yellow. Abdomen with the second and following tergites black; four pairs of gland-rods, the first reaching to base of segment 5 or rather beyond. Epping Forest; Holker and Grange, N. Lancs. (*Edwards*). This perhaps agrees best with Haliday's description, although the author does not mention the abdomen.

(*b*) Similar to (*a*) except that the face is black and the anterior part of the pleurae dark brown. Gibside, Durham (*Bagnall*).

(*c*) Scape and face black, anterior part of pleurae reddish. Abdomen mainly black; three pairs of gland-rods, the third short, the first reaching to base of segment 5. Gormire and Hawnby, Yorks. (*Edwards*).

(*d*) Scape reddish. Face dark brown. Anterior part of pleurae dark brown. Hind tibiae yellowish. First two abdominal tergites yellow, the rest blackish.

Four pairs of gland-rods, the first two each fully as long as the three preceding segments. Mundesley (*Verrall*).

(*e*) Scape reddish. Face black. Anterior part of pleurae dark brown. Hind tibiae dark towards the base. Abdomen with the first tergite and most of the second yellow, the rest dark brown. Two pairs of gland-rods, the first rather longer than the two preceding segments, the second not much shorter. Church Stretton, Salop (*Edwards*).

(*f*) Like var. (*e*), but hind tibiae not darkened at base, and a short third pair of gland-rods present. Letchworth, Herts. (*Edwards*).

2. **P. ephippium** (Zett.) (*rubra*, Kieff.). Very much resembles *P. distincta* var. *a*, except that all the abdominal tergites of the female are brownish (lighter or darker) the first one or two only indistinctly paler; there are no gland-rods even on the seventh tergite. Four specimens were mounted and compared, the possibility being thus eliminated that the absence of gland-rods is abnormal. In view of such a marked structural difference this form certainly seems to require separation from *P. distincta*. Lochinver, Sutherland (*Yerbury*); Corriegills, Arran (*Edwards*).

3. **P. armipes** (Mg.) (*erythrocephala*, Staeg.; *rufipectus*, Winn.). Larger than *P. distincta*, resembling *P. flavipes* in size. Scutum, scutellum and abdomen entirely shining black, at most the shoulders reddish; head, or at least the face, scape of antennae and a large part of the pleurae reddish. Legs mainly black. Five pairs of gland-rods, the fifth quite small, the first reaching to middle of fourth segment. New Forest (*Sharp*); Castle Howard, Yorks. (*Edwards*); Horning, Suffolk (*Morley*).

4. **P. spinipes** (Mg.) (*crassipes*, Goet.). Body all shining black. Halteres yellow. Costal and radial cells darkened, the rest of the wing clear. Only two pairs of gland-rods on female abdomen, the first not reaching beyond base of sixth segment. S. Uist, vi.1910, 1 ♀ (*Grimshaw*).

5. **P. grossipes**, Goet. Black, including the halteres. Five pairs of gland-rods, the fifth pair short; first pair slender, reaching to base of fourth segment. New Forest, vi.1904, 1 ♀ (*Sharp*). If Haliday's *brachialis* was not *P. nemorivaga* it may have been *P. grossipes*.

Group C.

Front femora moderately swollen, with 3–10 spines beneath. Middle and hind femora with at least one spine each. Claws of female with a small tooth near the base on the inner side.

This is a less natural group than the other two. Only four species have been recognised in Britain at present; they differ from one another very much in colouring and in some structural details. *P. tibialis* (Mg.) was recorded by Walker, but no specimens can be traced and the record needs confirmation.

1. **P. lineata** (Mg.). (Text-fig. 3*b*.) Differs from all the other British species, having the thorax dull greyish with dark brown markings, approaching *Sphaeromias fasciata* in this respect as well as in its size. Femoral spines approximately 10. 3. 1. Last segment of hind tarsi with 2–4 curved spiny bristles on one side, as in *P. semiermis*, Goet. Female abdomen with three pairs of glands, two short and one long, all simple. There is a short additional pair of gland-rods on tergite 4; rods of tergite 7 reaching to base of tergite 5. Knob of halteres black. Male darker brown, the scutal markings indistinct. Common.

I have seen one abnormal example in which the radial cells are united into one, as in *Bezzia*.

2. **P. serripes** (Mg.) (*transfuga*, Staeg.; *tarsatus*, Zett.). Shining black. Legs mainly black, the tarsi pale. Halteres black. Sexes alike. Femoral spines 3. 1. 2 or 4. 3. 2. Female glands as in *lineata*. Rather common.

3. **P. fulva** (Mcq.), (*ferruginea*, Mg.; ♂ *spinipes*, Winn. *nec* Mg.; *parviforceps*, Kieff.). Male shining black, but with yellow halteres; femora yellow, the tips broadly black. Female with the thorax shining red; abdomen white, all the tergites membranous (dark colouring is due to food showing through the skin); only one pair of glands, the rods reaching to middle of segment 4. Femoral spines of female approximately 10. 4. 4. Rather common.

4. **P. brevicornis**, sp. n. Entirely shining black, except for the halteres and scutellum, which are clear yellow. Legs all black. Femoral spines 5–6. 1. 1. Antennae of ♀ shorter than usual in this genus, segments 10–14 being scarcely more than twice as long as broad, 2–9 shortly oval. Palpi short, second segment only 1·5 times as long as broad, fourth as long as the second, but more slender. Eyes separated by the width of four facets. Scutal pubescence very fine and uniform. Scutellum with four bristles. Abdomen shorter than in most species of the genus. Wings greyish, unmarked, venation normal; cross-vein well before the middle; base of cubital fork below the cross-vein. Wing-length, 1·8 mm.

Gorge of Dart, S. Devon, 1.vi.1920, 1 ♀ (*Edwards*). It is just possible that this may be *P. morenae*, Strobl, which is insufficiently described, but the yellow scutellum appears very distinctive.

BEZZIA, Kieff.

(Including *Probezzia*, Kieff.)

(Plate XCI, fig. 14, wing of *B. ornata*.)

Characters of *Palpomyia*, with the following exceptions: Scutum without trace of anterior tubercle. Front femora with at most three spines, often with none. Only one radial cell, vein R^2 absent. Median fork less broadly sessile, sometimes with a very short stalk.

The species without femoral spines have been separated by Kieffer under the name *Probezzia*; but I think the division unnatural. The spines, when present, vary in number in the different species from one to three, and the single spine of *B. ornata* is rather weak, so that the distinction is not really a sharp one, and moreover it is not supported by any other characters. Goetghebuer has used two other characters for dividing the genus into groups: the length of the eleventh segment of the male antennae, and the presence or absence of the small tooth on the inner side of the female claws. This arrangement is rather more natural than that of Kieffer, but the characters are not correlated in all species; I have preferred (for convenience) a rather different grouping, based chiefly on the colour of the legs and halteres, and dividing our 16 British species into four groups.

GROUP A.

Hind femora and tibiae either entirely black, or the femora only narrowly pale at the base. Halteres black. Female abdomen blackish, with one pair of glands; female claws simple (except in *flavicornis*). Eleventh segment of male antennae much longer than the fourteenth, the antennal plumes well developed. Species of moderate size and rather stoutly built; sexes similar in size.

Of this group we have five or six rather well-distinguished species :—

B. flavicornis (Staeg.) (*flavipalpis*, Winn.; ? *spinifera*, Goet.). (Text-fig. 3*c*.) Thorax entirely shining black, without grey dusting. Palpi yellow. Legs black, with pale tarsi; tip of middle tibiae yellowish. Front femora with 3–4 spines; female claws toothed; gland-rods as long as 4½ segments. Oxford (*Hamm*); Cambridge (*Jenkinson*).

B. albipes (Winn.). Thorax moderately shining, especially on the posterior part of the scutum; indications of two greyish stripes when seen from in front, more noticeable in the female. Palpi black. Hypopygium large. Femora and tibiae all black; front femora with 2–3 spines; tarsi with the first three segments white. Female claws simple; gland-rods as long as three segments.

B. calceata (Hal.). Possibly identical with *albipes*, but as described differs by the completely dull thorax. I have seen specimens answering to the description from Aldborough (*Collin*).

B. gracilis (Winn.) (*winnertziana*, Kieff.). Thorax as in *B. albipes*. Hypopygium small. Front and middle femora yellowish, with a dark pre-apical ring; front femora with one spine. Skipwith, Yorks. (*Edwards*). The species was renamed by Kieffer because *gracilis*, Hal., had been described earlier, but as both species have been removed from *Ceratopogon* to different genera I consider the new name unnecessary.

B. nigritula (Zett.) (*tenebricosa*, Goet.; ? *coracina*, Zett.). Entirely black, the tarsi more brownish; thorax scarcely shining, without distinct grey stripes. Front femora without spines. Gland-rods of female short, not longer than one abdominal segment. Arran (*Edwards*).

B. pygmaea, Goet. Thorax scarcely shining, black, with two greyish stripes which are more conspicuous in the female. Front and middle femora yellowish with a dark pre-apical ring; tibiae largely yellowish, with a dark ring before middle. Front femora without spines. Gland-rods of female short, as in the last, but pale. Closely resembles *B. ornata*, Mg., except for the black hind femora and the unarmed front femora. Radwell, Herts. (*Edwards*).

Group B.

Hind femora largely ochreous towards the base, or with a pre-apical ochreous ring. Halteres with blackish knob. Female abdomen blackish, at most with one pair of glands; claws simple. Male antennae with well-developed plume; eleventh segment longer than fourteenth. Small species.

I include two species here; they are evidently nearly allied to some of those of group A.

B. ornata (Mg.). Hind femora with about the basal two-thirds ochreous, the end black. Anterior femora with dark subapical rings; all tibiae with blackish rings before the middle. Front femora with one slender spine. Thorax dull black with two very conspicuous whitish lines (when seen from in front). Gland-rods of female as long as 3½ segments. Common.

B. multiannulata (Strobl). Resembles *B. ornata*, but the hind femora are dark, with a subapical ochreous ring; black rings of tibiae broader and placed in the middle; front femora without spine; female abdomen without glands. Snailbeach, Salop, 1 ♂ (*Edwards*).

Group C.

Hind femora ochreous, usually with a dark subapical ring; hind tibiae largely ochreous. Halteres with ochreous stem and brown knob. Female

abdomen brownish to black, with three or four pairs of glands, female claws toothed. Male antennae with the plume very slightly developed, eleventh segment shorter than or at most as long as the fourteenth. Rather large species, but male usually much smaller than the female.

I recognise five British species in this group. They are evidently nearly allied to some species of *Palpomyia*, e.g. *P. lineata*.

B. annulipes (Mg.). I follow Verrall's identification of this species, although our specimens do not entirely agree with Meigen's description; they have four scutal stripes in the female (the middle pair close together) as in the next two species, and the scutellum is reddish, whereas Meigen mentions three scutal stripes and a grey scutellum. Front and middle femora of female without dark rings; tibial rings not very dark and placed much before the middle. Front femora with 2–3 spines. Scutum brownish-grey, the stripes not conspicuous. Female abdomen blackish. Male claspers slightly bifid at the tip. Rather common. The *C. signatus* recorded by Walker was this species.

B. solstitialis (Winn.) (? *circumdata*, Staeg.; *hydrophila*, Kieff.). (Text-fig. 3*d*.) I consider this distinct from *B. annulipes* (as here determined) on account of the following differences:—All femora with a dark pre-apical ring; tibial rings darker and broader, especially that on the hind tibia. Scutum greyer, the stripes darker and more distinct. Abdomen of female with traces of two longitudinal paler stripes (as described by Haliday for *B. taeniata*); gland-rods longer, the fourth pair better developed; spermathecae with shorter necks. Male claspers tapering to a point. Our specimens differ from Staeger's types in having the dark ring of the hind tibia broad, and from Kieffer's description of *solstitialis* in having segments 12–14 of the male antennae longer. Rather common.

B. sp. indet. Differs from the last two in having the dark rings of the tibiae in and not before the middle; costa longer, reaching almost to above the tip of M_2; segments 13 and 14 of male antenna longer than segment 12; side pieces of hypopygium longer. Epping Forest, 1 ♂ (*Edwards*).

B. xanthocephala, Goet. Femora and tibiae without dark rings; front femora with two spines. Female abdomen pale. Scutum without distinct stripes. Wood Walton Fen, Hunts., 1 ♂ (*Edwards*).

B. rubiginosa (Winn.) (*nitidiventris*, Goet.). Femora and tibiae without dark rings; first femora without spines. Female abdomen blackish; gland-rods as in *B. solstitialis*, but spermathecae more unequal in size. Scutum uniformly dark reddish brown, slightly shining; pleurae blackish, shining. My specimens differ from Winnertz's description in having a very small tooth on each claw on the inner side; I consider that Winnertz probably overlooked this in his type, and if so there is nothing to distinguish *nitidiventris* from *rubiginosa*. Castle Howard, Yorks. (*Edwards*); Three Bridges, Sussex (*Verrall*).

Group D.

Hind femora black at the base and the tip, broadly yellow in the middle. Halteres pale yellow. Female abdomen partly or wholly white, with one pair of glands; claws toothed.

I include three species here.

B. taeniata (Hal.). According to Haliday's description this is something like *B. solstitialis*, except that the hind femora are black at the base, halteres yellow, front and middle femora black except at the base; female abdomen white, with an interrupted dark stripe down the middle, and a complete dark

stripe down each side. Front femora with two spines. I have seen no specimens answering to this description, and the species has not been identified by recent workers. Recorded by Haliday from near Belfast.

B. nobilis (Winn.). Scutum mainly rather light grey; with a narrow dark brown stripe down the middle, less distinct in the male owing to the dark ground-colour. Anterior tibiae with a dark ring near the base, hind tibiae black with a broad yellow ring beyond the middle. Front femora with three spines. Wings not distinctly milky. Gland-rods of female abdomen as long as 4½ segments. Antennae of male with well-developed plumes, the eleventh segment much longer than the fourteenth. Sexes similar in size. Hind tibiae of male bristly; middle and hind femora in both sexes with 1–3 slender spines beneath. Abdomen of female all white. Castle Howard, Yorks. (*Edwards*); Slieve League, Donegal (*Lamb*).

B. bicolor (Panz.). Resembles *B. nobilis* in colour, but the dark median stripe on the scutum is narrower; front tibiae narrowly black at base and tip and with a black ring near the middle; hind tibiae black at the base and tip only; wings milky white; femora all unarmed. Gland-rods as long as three segments. Male much smaller than the female; antennae with the plumes very little developed, eleventh segment not longer than the fourteenth. Rather common.

LITERATURE.

The following are the principal papers published recently relative to European CERATOPOGONIDAE :—

CARTER, H. F., INGRAM, A. and MACFIE, J. W. S. (1920–1924). A series of papers on West African CERATOPOGONINAE, containing a full morphological description of the genera dealt with (*Culicoides*, *Dasyhelea* and others). Annals of Tropical Medicine and Parasitology.

EDWARDS, F. W. (1920). Scent-organs (?) in female midges of the *Palpomyia* group. Ann. Mag. Nat. Hist., (9), vi, pp. 365–368.

EDWARDS, F. W. (1920). Some records of predaceous Ceratopogoninae. Ent. Mo. Mag., lvi, pp. 203–205.

EDWARDS, F. W. (1921). Diptera Nematocera from Arran and Loch Etive. Scot. Nat. March-August 1921, pp. 59–61, 89–92, 121–125.

GOETGHEBUER, M. (1919). Metamorphosis et mœurs de *Culicoides pulicaris*, L. Bull. Soc. Ent. Belg., i, pp. 30–31.

GOETGHEBUER, M. (1920). Ceratopogoninae de Belgique. Mem. Mus. Nat. Hist. Belg., viii, fasc. 3.

GOETGHEBUER, M. (1921). Chironomides de Belgique, et specialement de la zone des Flandres. Mem. Mus. Nat. Hist. Belg., viii, fasc. 4.

GOETGHEBUER, M. (1922). Étude critique des *Ceratopogon* de la collection Meigen. Bull. Soc. Ent. Belg., iv, pp. 50–59.

GOETGHEBUER, M. (1922–3). Nouveaux matériaux pour l'étude de la faune des Chironomides de Belgique. Ann. Biol. Lacustre, xi, pp. 38–62 and xii, pp. 103–120.

KIEFFER, J. J. (1917). Chironomides d'Amerique conservés au musée national hongrois de Budapest. Ann. Mus. Nat. Hung., xv, pp. 292–296 [key to genera of CERATOPOGONINAE].

KIEFFER, J. J. (1919). Chironomides d'Europe conservés au musée national hongrois de Budapest. Ann. Mus. Nat. Hung., xvii, pp. 1–131.

KIEFFER, J. J. (1922). Nouveaux chironomides piqueurs habitant l'Algérie. Arch. Inst. Pasteur Afr. Nord., ii, pp. 494–518.

KIEFFER, J. J. (1925). Faune de France. Diptères (Nématocères piqueurs): Chironomides Ceratopogoninae. Paris, Lechevalier.

SAUNDERS, L. G. (1924). On the life-history and anatomy of the early stages of *Forcipomyia* (Diptera, Nemat., Ceratopogoninae). Parasitology, xvi, pp. 164–212. [Contains descriptions of *F. radicicola* and *F. pulchrithorax* by Edwards.]

SAUNDERS, L. G. (1925). On the life-history, morphology and systematic position of *Apelma*, Kieff., and *Thyridomyia*, n.g. (Diptera, Nemat., Ceratopogoninae). Parasitology, xvii, pp. 252–277.

EXPLANATION OF PLATES XCI–XCII.

PLATE XCI.

Wings of British genera of CERATOPOGONIDAE.

(Various magnifications. In each case the female wing is shown.)

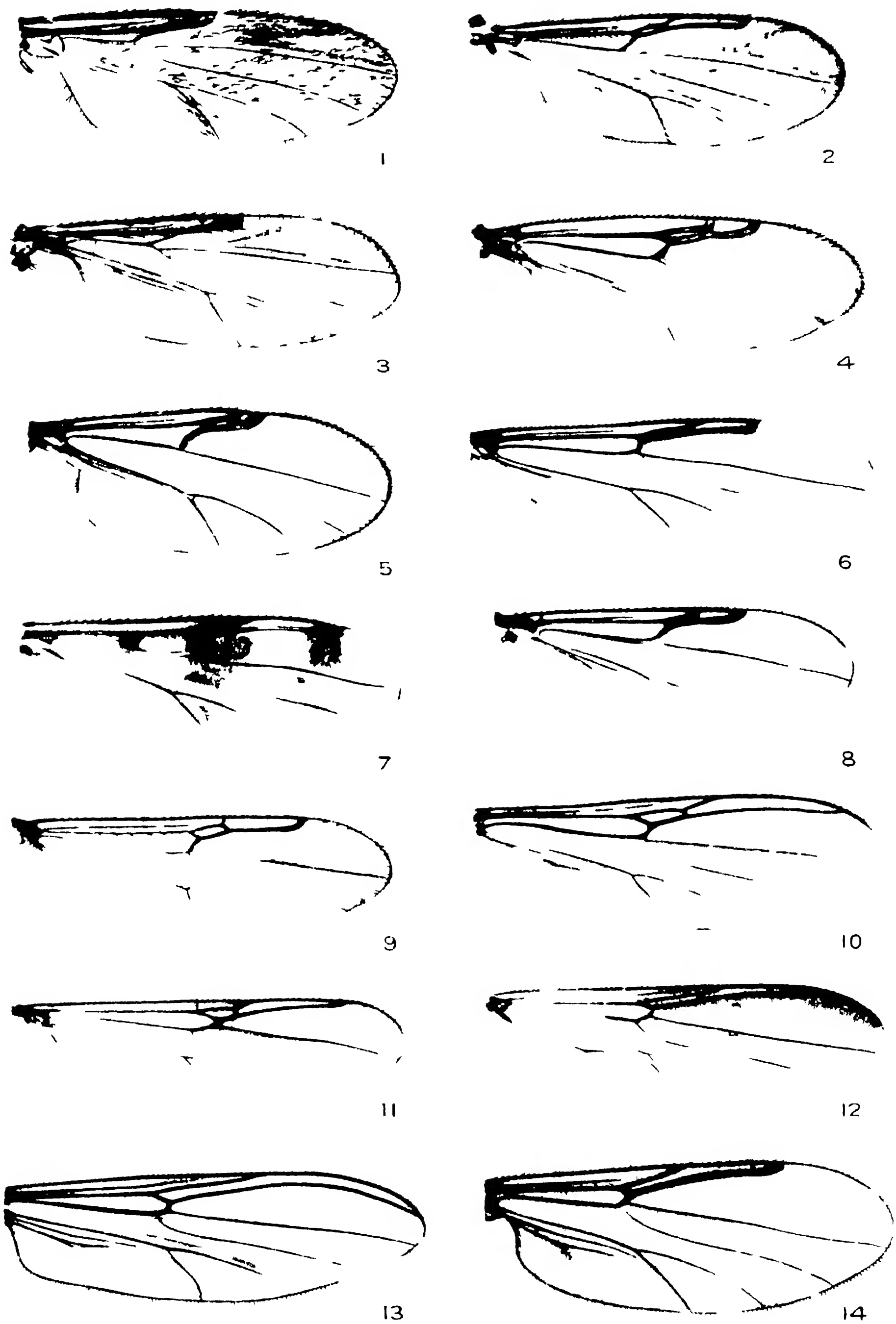
FIG. 1. *Forcipomyia brevipennis* (Mcq.).
2. *Atrichopogon lucorum* (Mg.).
3. *Dasyhelea holosericea* (Mg.). Macrotrichia not shown.
4. *Ceratopogon niveipennis*, Mg.
5. *C.* (*Isohelea*) *sociabilis* (Goet.).
6. *Serromyia morio* (Fab.).
7. *Monohelea tessellata* (Zett.).
8. *Schizohelea leucopeza* (Mg.).
9. *Stilobezzia gracilis* (Hal.).
10. *Neurohelea luteitarsis* (Mg.).
11. *Clinohelea unimaculata* (Mcq.).
12. *Palpomyia semifumosa*, Goet.
13. *Dicrobezzia venusta* (Mg.).
14. *Bezzia ornata* (Mg.).

PLATE XCII.

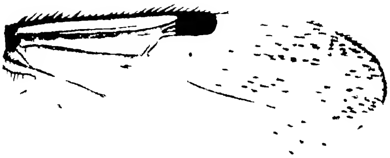
Wings of British species of *Culicoides*.

(Various magnifications.)

FIG. 15. *C. parroti*, Kieff.
16. *C. obsoletus* (Mg.).
17. *C. vexans* (Staeg.).
18. *C. winnertzi*, nom. n.
19. *C. circumscriptus*, Kieff.
20. *C. nubeculosus* (Mg.).
21. *C. pictipennis* (Staeg.).
22. *C. arcuatus* (Winn.).
23. *C. pulicaris* (L.) var. *a*.
24. ,, var. *b*.
25. ,, var. *c*.
26. ,, var. *d*.



WINGS OF CERATOPOGONIDAE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WINGS OF CERATOPOGONIDAE

THE PHENOMENON OF MYRMECOIDY, WITH NEW EXAMPLES FROM CUBA

By J. G. Myers and George Salt.

With an Appendix by N. Banks and H. G. Barber.

(No. 3, Studies from the Biological Laboratory in Cuba (Atkins Foundation) of the Harvard Institute for Tropical Biology and Medicine.)

[Read June 6th, 1926.]

Plate XCIII and one Text-figure.

In the vicinity of the Harvard Biological Station at Soledad, Cuba, the sweeping of miscellaneous bushes, whether in the lowlands or in the hills, almost invariably produced numerous ants, among which none was more plentiful than the red and black *Camponotus planatus*, the striking orange and black *Pseudomyrma flavidula* var. *pazosi* and the brown *Pseudomyrma elongata* var. *cubaënsis*. In the same surroundings and not infrequently in the same netful one often found other arthropods resembling in the greatest detail one or another of these common ants. The resemblance was so perfect, in size, in colour, in markings and in behaviour that we were repeatedly deceived even when on the watch. We figure the spiders and insects concerned as examples in a discussion of the ethological * significance of myrmecoidy.* The recent and voluminous contributions by Heikertinger, Wasmann and other continental workers have received little attention from English-speaking entomologists, and the time is perhaps opportune for a brief review. We may first briefly describe the ants and the animals which specifically resemble them, and then pass to a review of the theoretical implications.

For determinations or for checking identifications we are indebted to the following authorities : Professor W. M. Wheeler for the ants, Mr. N. Banks for the spiders, Mr. H. G. Barber for the Lygaeids and Dr. G. A. K. Marshall for the weevil. Both Dr. Wheeler and Professor Poulton have also read the manuscript and criticised it helpfully.

The Ants, and the Animals which specifically resemble them.

(1) *Camponotus planatus*, Roger.

This very common Cuban ant is frequently caught in the sweeping-net and may be observed, also abundantly, running upon the trunks and branches of trees, often with its abdomen bent forward and under its thorax in a peculiar manner. The coloration, as indicated at Plate XCIII, fig. 1, is distinctive and by no means usual. The gait is that quick and nervous run which one is impelled to characterise as " busy," and which is, moreover, too familiar to need description.

The commonest form resembling *Camponotus planatus* is the identically coloured Clubionid spider, *Myrmecotypus cubanus* (Plate XCIII, fig. 2), described as a new species by Mr. Banks at the close of this paper. This

* See Postscript.

spider occurs in the same ethological stations. The plate will show its great likeness in colour and in form to the above-mentioned ant; but no illustration can indicate a third and very striking factor in the resemblance. The gait, namely, is indistinguishable from that of the ant, and the first pair of legs is engaged in palpating the substratum in a manner at once suggestive of the movements of an ant's antennae.

The second myrmecoid arthropod in this group is the weevil, *Otidocephalus poeyi*, Chev. (Plate XCIII, fig. 3). As this beetle was taken only once, observations upon it were necessarily scanty. From a field note it was found to walk "very like an ant—only a little slower. The only weak spot is the beak, which is carried quite conspicuously in front" (March 23rd, 1925).

(2) *Pseudomyrma elongata*, Mayr, var. *cubaënsis*, Forel.

We have seen that while the form of *Camponotus planatus* is like that most commonly associated with the family, the coloration is distinctive (Plate XCIII, fig. 4). In the present genus the shape of the body is somewhat specialised. A resemblance by another arthropod, to be perfect in this case, must then do more than follow merely the general ant-shape. The colours of the present species are brownish and obscure. Of the three ant species considered in this paper, the one under discussion is the commonest, occurring sometimes in such numbers as to cause considerable irritation by merely crawling upon one's person.

In coloration and in markings, and much more effectively in its elongate form, *Pseudomyrma cubaënsis* is closely resembled by the small Attid spider, *Synemosyna smithi*, Peck. (Plate XCIII, fig. 5). Both in this and in the preceding case it was noticed that small instars or individuals of the spider concerned, resembled small workers of the appropriate ant. Nevertheless there were indications that progress towards perfection of myrmecoidy accompanied the growth of the spider. Like *Myrmecotypus*, *Synemosyna* had a most ant-like gait and used its first pair of legs in a very antenna-like manner.

Another arthropod taken with *Pseudomyrma cubaënsis* and resembling it with deceptive closeness was the Lygaeid bug, *Pamphantus mimeticus* (Plate XCIII, fig. 6), described as new by Mr. H. G. Barber in the Appendix. Again the bearing of the living insect was strikingly ant-like.

(3) *Pseudomyrma flavidula*, Sm., var. *pazosi*, Santschi.

Here is an ant with a specialised, elongate form and a vivid orange and black colour pattern presenting an *ensemble* so distinctive (Plate XCIII, fig. 7) that there can be no question but that any resemblance to it can be effective only by being specific.

The perfection of the likeness which has been achieved by at least two arthropods may be gauged from the figures and from the field notes made on the discovery of their subjects. "Ant-mimic association on undergrowth (shrubs and lianes) under trees of creek-bed. First beat a beautiful Lygaeid mimic of the common orange and black *Pseudomyrma*. Determined to see whether model in same situation. Beat again and got one, examined it alive in the net for some time and noted how exactly like it the bug had run. Put in alcohol and examined closely with lens, comparing it with the bug and to my great astonishment found supposed ant was an Attid spider. Beating same place obtained more bug-mimics and spider-mimics, and nymph of former. Finally, in a few hours' beating along 20 yds. of creek got altogether

one sp. Lygaeid with its nymph, both mimicking same *Pseudomyrma*, an Attid mimicking same ant and the model itself" (Soledad, 6th March, 1925).

Thereafter we found the ant together with the spider and the Lygaeid more frequently, and attempted to secure a series of the two latter. But even after a week of such collecting we more than once rejected a supposed example of the "ant" from the net only to see it suspend itself at once by a silken thread. We did not once see any sign of direct relations between the ant and either the spider or the bug. Yet Reichensperger (1925, p. 295) writes of *Pamphantus elegantulus*, "die nebst ihren Wirtsameisen unerkannt mitten aus dem Nest heraus gegriffen und an Dr. Santschi gesandt wurde; sie ist, wie mir Herr Dr. Bergroth kurz mitteilte, bereits früher unter ähnlichen Umständen an ihn gelangt, und sie besitzt in Farbe, Form und Grösse eine geradezu verbluffende Ahnlichkeit mit dem Wirt." We took numerous examples but never one from a nest.

The case of the spider (Plate XCIII, fig. 8) is especially interesting in that the form resembling *Pseudomyrma flavidula pazosi* and that mimicking the very differently marked *Ps. cubaënsis* are mere colour varieties of the same species, *Synemosyna smithi*. Here is a case recalling that of some of the polymorphic PAPILIONIDAE, but occurring among some of the smallest arthropods from which mimicry phenomena have been recorded.

The adult bug, *Pamphantus elegantulus*, Stål (Plate XCIII, fig. 9), is somewhat handicapped as an ant-mimic by its hemielytra, though the difficulty is overcome to a certain extent by a method very common in Myrmecoid Heteroptera; namely, the appearance of pale markings simulating a narrowing of the body where the ant-waist would be. This device is not, however, so effective as the actual thin waist of the *Pamphantus* nymph, which is thus a much better "mimic" of the same ant than is the imago.

In both spider and bug the likeness to the ant in gait is very close, while the agreement in colour and pattern is nearly perfect. Professor Poulton has drawn our attention to an interesting point in that whereas the bug "mimicks" the black eyes of the ant with its own eyes, the spider, with its optical organs in quite a different position, does so by means of long black spots and achieves the same end much more effectively.

DISCUSSION.

That the above group of arthropods, consisting of three ants, three spiders of two different families, two bugs and a weevil—the latter six resembling the former three with such an exactitude of morphological and ethological detail as to deceive more than once the fore-warned judgment of the entomological collector—presents a very real problem in biology is a point which surely need not be laboured. We have tried to set out the facts in terms as non-committal as possible, in order to leave a free field for discussion.

The explanation on the orthodox hypothesis of mimicry would ascribe the myrmecoidy of these unrelated animals to the influence of natural selection operating through the advantage accruing to ant-resembling forms in the struggle for existence. Theoretically this advantage might accrue in one or more of three ways; practically and experimentally it is extremely difficult to demonstrate it in any one of them.

Wasmann, the veteran student of myrmecophily (1925) sees in myrmecoidy no biological significance unless the phenomenon is associated with the myrmecophilous habit. The well-known case of the Anthicid beetles, for

example, is not one of true mimicry since these beetles enter into no ethological relations with the ants. True ant-mimicry, in Wasmann's opinion, is exhibited only in the resemblance of ant-guests to their host-species. Its function is to deceive the host-ant in order that the guest may either devour ants and brood, or pursue in or near the nest more peaceable occupations undisturbed by the former. Whether there is sufficient evidence to support such a theory of ant-mimicry is a question for those specialised in the study of ants and of myrmecophiles. Dr. W. M. Wheeler, whom we consulted upon this point, considers it at present an open question, but believes that another factor, that, namely, of convergence or adaptation to similar conditions, has received less attention than it merits. He would ascribe the cuticular texture and physogastric tendency of so many termitophiles to the same causes which have at least helped to develop them in the termites themselves, viz. the very peculiar environment, physical and organic, furnished by the interior of a termitarium. In the case of the myrmecophiles, much of the resemblance commonly attributed to mimicry, may be a direct adaptation to life among the ants, as Wheeler has noted in the following passage (1922, p. 625, in letter quoted by Mann) :—

"Wasmann, in dealing with the ecitophiles of the Neotropical and the dorylophiles of the Ethiopian Region, has elaborated hypotheses of mimicry, hypertely, etc., to account for the ant-like appearance of some of these insects. *Mimanomma* he regards as a case of hypertely—one in which the insect has become an example of greatly and uselessly exaggerated mimicry of its host ('über das Ziel hinausschiessende Mimicry'). As it is rather important that such speculations, which are easily excogitated in laboratories and museums, should not be left in undisputed possession of the field of theoretical biology, I advance another hypothesis which seems to me worthy of consideration. It is well known that bivouacking dorylines, and especially the species of *Anomma*, form great masses, like swarming bees, with their long legs, antennae and bodies interlaced and enveloping the brood, booty, and guests. Long, slender insects like *Mimanomma* and even those of Wasmann's 'Trutztypus,' which have the very opposite shape, being short and broadly rounded anteriorly, with rapidly tapering posterior end, would be beautifully adapted for forcing their way through and moving about in the forest of legs, antennae and bodies of the bivouacking ants, much as both very thin, long, insinuating and small, rotund, pushing people seem to be better adapted for shouldering their way through a crowd than people of average stature. Hence, the peculiarities of form referred by Wasmann to mimicry, hypertely, etc., may be really direct and useful adaptations to the very peculiar nest environment created by the densely agglomerated bodies of their hosts. I have seen such conditions in ecitophile-containing artificial nests of our North American *Eciton* (*Acamatus*) *schmitti*, Emery, and *opacithorax*, Emery, and have no doubt that future observers will be able to make similar observations on *Anomma* and its guests. . . ."

But whatever the decision as to the ethological value of myrmecoidy to ant-guests, it is important to realise that this is only a small part of the problem. Many of the most striking cases of myrmecoidy occur, as probably in the Cuban examples discussed in the present paper, among arthropods which have not been demonstrated to enter into any ethological relations with the ants; among animals dwelling together with so many diverse forms in the same ethological stations as to render any theory of convergence extremely improbable.

It may, we think, be said without fear of contradiction that most mimeticists consider other conceivable functions of myrmecoidy more important than those stressed by Wasmann. It is, in fact, far more plausibly maintained that the chief advantage of ant-mimicry lies in the protection afforded from the attacks of predaceous animals, a theory which brings myrmecoidy into line with other forms of mimicry as explained by the natural selection hypothesis. Even some ant-students, notably Donisthorpe, take this view, or at least carefully distinguish two kinds of ant-mimicry—that exhibited by ant-guests and that of insects having no direct relations with the ants. Heikertinger (1919) has followed Jacobi in calling these two forms of ant-resemblance, "synöke Myrmecoidie" and "metöke Myrmecoidie" respectively. In his numerous discussions of the theory of mimicry Heikertinger has suggested that the phenomena usually grouped under this head be classified into *Mimesis*, in which protection is attained by resemblance to some common feature of the organic or inorganic environment, *i.e.* by inconspicuousness, and into *Mimicry* in a restricted sense in which the same end is reached by the imitation of a dangerously armed or distasteful organism which is correspondingly "warningly coloured," *i.e.* by conspicuousness. In Heikertinger's view, then, synoeketic myrmecoidy would correspond with myrmecomimesis (since its object is to pass unnoticed among the host-ants), while metoeketic myrmecoidy would be equivalent to myrmecomimicry (since its "aim" is to persuade a predator that the harmless mimic is a well-armed or distasteful ant). Wasmann (1925) has strenuously opposed both Heikertinger's terminology and the concepts which it is designed to express. We have already seen that he denies biological significance to metoeketic myrmecoidy and stresses the value of the contrasted kind. He further characterises the term "mimesis" as unnecessary. It is certainly unfortunate that however distinct the two terms are as substantives, in using them adjectivally we have only the one expression "mimetic," which at present is applied most commonly to forms which resemble supposedly distasteful species and thus exhibit the phenomenon of mimicry in the strict sense. This is therefore a point in which the well-known Poulton terminology is preferable to the new scheme suggested by Heikertinger (1925 and earlier papers).

The necessary support for the more popular theory that myrmecoidy serves to protect its exponents from predaceous enemies in general rather than from the ants themselves, lies in a demonstration that ants are immune from the attacks of predaceous enemies to a sufficient extent to render such relative immunity worth sharing. In the more general mimicry problem Poulton and others have shown that predaceous arthropods display very little discrimination in the choice of prey. This applies to general feeders which are, of course, the only kind against which mimicry would conceivably act as a defence; for the activities of such specialised predators as many of the solitary wasps necessarily lie as far outside the range of the mimicry problem as do those of specific parasites. We therefore find considerable agreement that the devices of the mimetic insect are operative, if at all, against the attacks of vertebrate enemies. In the case of myrmecoidy the direct evidence that ants are in any way protected against insect-eaters appears to be almost lacking. Its extent has been indicated by Poulton (1924). On the other hand, data to show that these insects form a frequent and considerable portion of the diet of many diverse vertebrates seem to be steadily accumulating (Heikertinger, 1919, 1923 *a*, *b*, 1925; Bequaert, 1922).

In commenting on the exhaustive treatise of Bequaert on the predaceous

enemies of ants, Poulton (1924) claims that the very fact that ants are dominant insects, common and conspicuous and "advertised by their communities as well as by their appearance . . . in itself supplied the evidence of special defence that Dr. Bequaert apparently believed to be lacking." He further considers that the very facts of myrmecoidy, the great variety of means by which ant-resemblance is brought about and the modification of colour, form and behaviour which contribute to the result, all compel us "to believe that there is something advantageous in the resemblance to an ant, and that natural selection has been at work. The phenomena do not merely disprove all other suggested causes of change, but they constitute the most powerful indirect proof of the operation of natural selection" (Poulton, *l.c.*, p. lxx, cited from a previous contribution). Such is the stoutest definition of the selectionist position. As a hypothesis it is logically perfect, but its discussion on theoretical grounds is rapidly approaching an *impasse*, or at least developing into a polemic in which the side one takes depends more upon one's general philosophic views than upon the objective value of the available data. This is nowhere better shown than in the not infrequent use of the same facts by opposing sides in the discussion. Thus the hypertelic development of leaf-resemblance in certain Phasmids, where even the spots due to the attacks of specific fungous diseases are faithfully reproduced, has been variously interpreted as unnecessarily detailed and thus not producible by natural selection or as an example of the perfection attainable by the same agency.

In the case of myrmecoid spiders, especially those dealt with here, though they cannot be considered myrmecophiles since they do not occur in the nests of the ants, yet we must not lose sight of the possibility that they prey on the ants. Thus Pickard-Cambridge (1898) writes of the nearly related *Myrmecotypus pilosus* (P.-Cambridge) of Mexico, "Mr. Smith has the following note on this species: 'Female in a leaf, in thick woods near a stream; it was sitting on the point of the leaf with the front legs extended. A black ant resembling this spider is common in the same woods. According to my observations, these ant-like spiders eat only the species of ant which they resemble. . . .'" In Cuba we did not observe any of the spiders feeding on the ants which they resembled, but we have very little data on any of their prey.

Fulton (1918) dealing with quite another kind of predaceous myrmecoid, namely the Mirid bug, *Pilophorus walshii*, Uhler, found that in this case the mimic fed upon aphides and kept carefully out of the way of the model, while the ant attacked the bug if a meeting did take place. Fulton's conclusion shows that he overlooked the possible protective value to the bug of a resemblance which might deceive vertebrate enemies; for he remarks, "In consideration of the poor visual powers of the ants and the helplessness of the aphids, it is hard to imagine how the striking resemblance of *Pilophorus* to the ants . . . can be of any value to the species either for protection or aggression. The only logical conclusion seems to be that the resemblance is purely accidental."

In conclusion, we are then warranted in asking for experimental evidence as to the ethological value of myrmecoidy and we may surely hope that this will come with the realisation that the ethological relationships of organisms are much more complex than anyone has yet visualised, and in the practical corollary, stressed by Heikertinger, that each case of myrmecoidy must be studied individually in field and laboratory on its own merits. Meanwhile the accumulation of the mere facts of myrmecoidy, as in the present paper, may help towards the eventual solution of the problem.

Those who have so far opposed the orthodox mimicry hypothesis in its explanation of the facts of myrmecoidy have, especially in the case of Heikertinger, been sufficiently negativist to attribute the phenomena in question to chance. Thus Heikertinger (1919) states that " ant-resemblance is due to chance. By the laws of chance it would be more wonderful were there no ant-resemblance." (Translation.) The same writer in 1923 (p. 178) remarks, " Es gibt eine Ameisenähnlichkeit, wie es tausendfache Aehnlichkeit in der Lebewelt gibt, die Ameisenmimikry aber ist eine Hypothese, für welche alle Voraussetzungen in der Tatsachenwelt fehlen." Finally, in 1925 (p. 289) he concludes, " Die Ameisenmimikry ist effectiv tatsachengemäss erledigt."

We may agree with Heikertinger that ants are dominant insects, and that it would perhaps be extraordinary if among the uncounted thousands of other terrestrial arthropods there were not some which " happened " to resemble ants; but when the likeness is so specific and so exact as in the examples figured in the present paper, however agnostic we may feel towards the orthodox mimicry hypothesis, we can hardly view with less incredulity an appeal to chance. Even a specific resemblance, did it affect form alone, or colour alone or behaviour alone, might conceivably be fortuitous, but when all three elements of agreement are combined in the same individual, occurring in the same stations as the form it resembles, and this not in one species but in most clear examples of myrmecoidy, " one can only say," of such an explanation " as did the old orthodox Christian of the doctrine of atoms and fortuitous combinations, that it put upon the back of chance more than it could bear."

Appendix.

Description of New Species.

Myrmecotypus cubanus, sp. nov., described by N. Banks, with figure.

Cephalothorax reddish-brown, faint brown marks in front of dorsal groove, mandibles and sternum paler, abdomen black on the shield, rather paler behind it, before middle with a band of white scale-like hairs, behind shield is longer white hair. Femora red-brown, hind pairs with pale stripe above, rest of legs paler, tarsi very pale. Cephalothorax rather more slender than in *M. fuliginosus*; both eye-rows nearly straight, A.M.E. much larger than others, A.S.E. smaller than

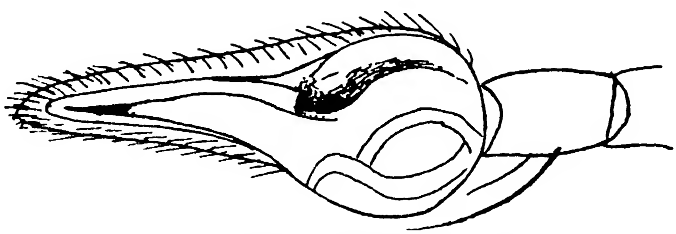

Fig. 1.—*Myrmecotypus cubanus*, sp. nov. Male palpus.

others, quadrangle of M.E. rather longer than broad, and as broad behind as in front, P.M.E. fully two diameters apart, almost twice as far from each other as from the equal P.S.E. Mandibles with two small teeth on posterior side. Maxillae long, truncate at tip, outer sides nearly straight, more than twice as long as the lip.

Legs about as long as in *M. fuliginosus*, in male a little longer; with few spines, one above on each femur near middle, two or three below on tibiae, and one or

two below on metatarsi, the front tarsi scarcely two-thirds as long as the metatarsi. Abdomen as in *M. fuliginosus*, rather broader behind middle, on basal two-thirds with a large corneous shield, broadly rounded behind; venter with long pale hair; sternum slender, hardly as much so as in *M. fuliginosus*.

Length, cephalothorax, 1·5 mm.; abdomen, 1·5 mm.

One male and an immature female from Soledad, Cuba, 6th March (*J. G. Myers coll.*).

Pamphantus mimeticus, sp. nov. (Hemiptera; LYGAEIDAE), described by H. G. Barber, Roselle, N.J.

Dark castaneous brown or fuscous, somewhat shining. Pronotum with a transverse white band between the two lobes; corium with an elongate triangular basal white fascia occupying nearly one-half of the length but inwardly not quite reaching the clavus, and also a small preapical whitish patch. Membrane with a sub-basal lacteous fascia followed by a transverse, somewhat lunate one. Antennae stramineous except at extreme base and apex. Margins of acetabula, posterior margin of metapleura, four marginal fascia of connexivum, bases of femora, the tibiae and tarsi, white.

Head with the vertex rather flattened, one-third wider than long, a little wider than the posterior lobe of the pronotum, finely rugulose, anteriorly sparsely pilose. Eyes rather large, strongly projecting, the diameter of an eye nearly one-half that of the vertex. Ocelli widely separated, placed far back and close to the eyes, about five times as far apart as each from the eyes; post-ocular distance very short, the eyes almost in contact with anterior margin of pronotum; antenniferous tubercles outwardly lightly prominent at apex, the lateral margin of this quite evidently longer than the post-ocular margin and about one-half the length of the first antennal segment. Antennae relatively short but longer than head and pronotum taken together; basal segment short and stout, brownish at base, second and fourth subequal, the latter elongate spindle-formed, dusky at tip, third one-fourth shorter than second, widening towards apex. Bucculae very short, not reaching back of base of antennae. Rostrum rather short, reaching to a point midway between the anterior and intermediate coxae; basal segment short, reaching just past middle point of head (remainder obscured). Pronotum elongate, somewhat depressed, nearly one-third longer than head; lateral margin lightly impressed within the lateral margin of the propleura; very sparsely pilose anteriorly and laterally; the two lobes separated by a shallow obtuse groove; anterior lobe nearly quadrate, with the lateral margin lightly convex, twice as long as posterior lobe and somewhat narrower; collar absent, but along anterior margin furnished with two or three rows of coarse punctures, also two or three rows of punctures just anterior to the transverse groove; between these two series of punctures the central impunctate disk is crossed by a median row and also a longitudinal row of punctures; posterior lobe anteriorly white and there coarsely punctate, posteriorly sparsely punctate; posterior margin lightly concave in the middle, narrowly bordered with white on either side. Scutellum as long as wide, coarsely punctate. Clavus fuscous, gradually widened posteriorly, provided with three regular rows of punctures; commissure a trifle longer than scutellum. Corium with the costal margin scarcely expanded, lightly concavely arcuated opposite the centre of the commissure; apex not quite reaching as far as the middle line of the membrane; inwardly along the claval margin with one regular and one incomplete row of punctures, another row of punctures along the median vein posteriorly and continued along the apical margin of the corium. Membrane not quite extended to the apex of the abdomen; veins not distinctly elevated. Pro- and meso-pleura coarsely punctate; metapleura finely punctate. Anterior coxae remote from the intermediate pair; all of the femora incrassate; somewhat clavate, the anterior

pair more robust, not extended anteriorly before apex of head, armed with a single tooth near middle; tibiae pale, finely pilose; hind tarsi with the basal segment a little longer than second and third together. Venter smooth, shining, impunctate, first three segments fused together, very finely pilose; the lateral margins narrowly impressed. Genital segment swollen, rounded. The abdomen as long as the head and thorax taken together.

Length 3·70 mm.

Type: a single male from Soledad, Cuba, collected by Dr. J. G. Myers, March 13, 1925.

Only a single member of this genus has hitherto been known, *P. elegantulus*, Stål, also described from Cuba, several specimens of which I have seen in the U.S. National Museum. In shape, both these species resemble members of the genus *Ischnodemus*, and are mimetic of certain ants, according to Myers. They do not appear related to any other forms of MYODOCHINAE known from the United States. They were placed by Stål in the division or tribe Rhyparochromini. Besides the great colour distinctions *mimeticus* may be distinguished from *elegantulus* by the transverse groove of the pronotum being placed further back and the costae being more nearly parallel.

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Postscript.—Professor Poulton has very kindly given us timely warning that two of our terms are practically new to mimicry literature in this country;

so we deem it advisable to offer some justification for their use. "Myrmecoidy," since it means merely "ant-resemblance" and thus carries no implication regarding either the origin or the "use" of such resemblance, has been used instead of "ant-mimicry."

"Ethology" (St. Hilaire, 1859), "oecology" (Haeckel, 1866) and "bionomics" (Ray Lankester, 1889) form, as Wheeler has shown, a family of synonyms, to which the latest addition is "behaviour" (Lloyd Morgan, Whitman, Watson). For reasons of general appropriateness and priority we have used the first.

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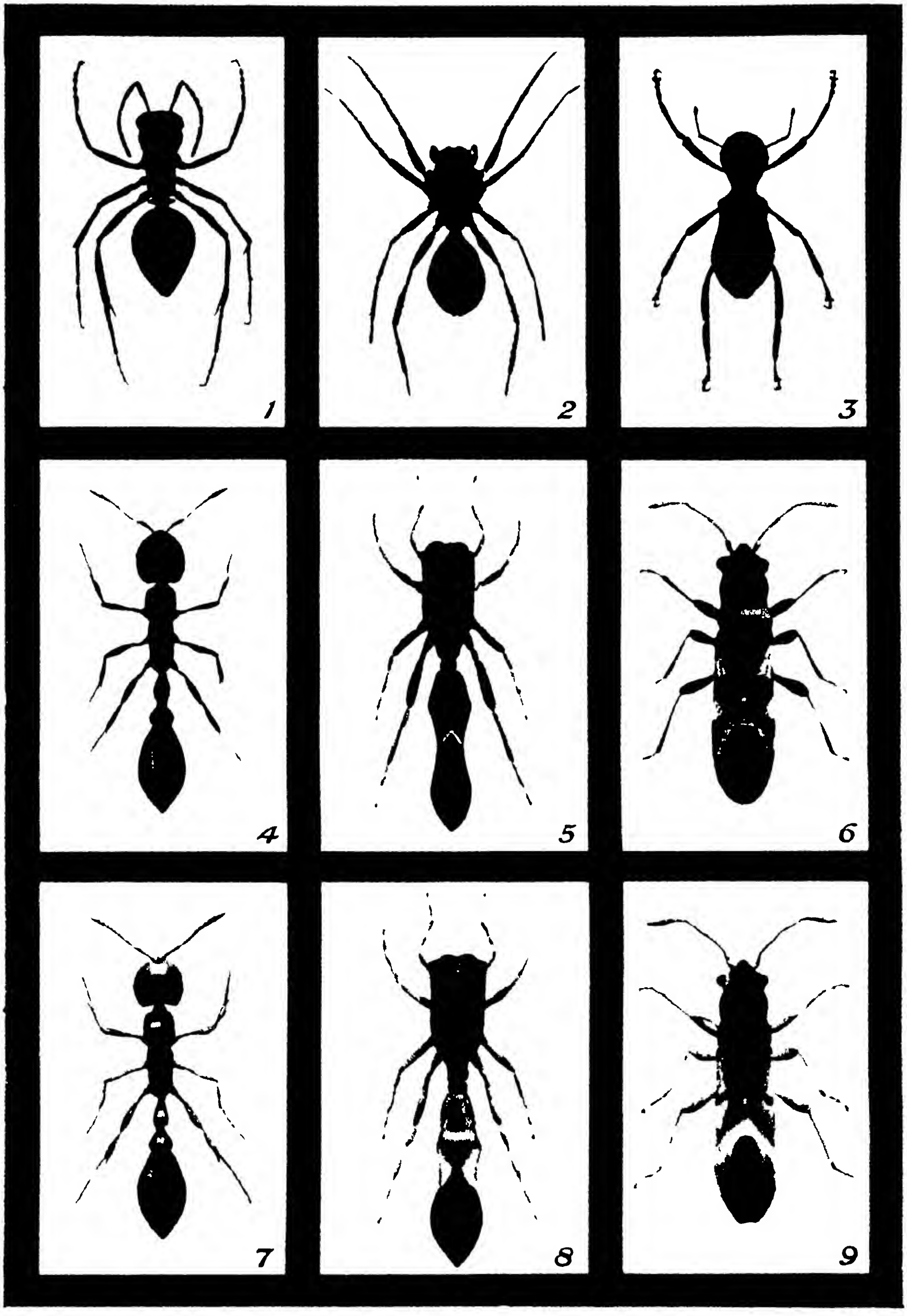
WESTWOOD BEQUEST



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EXAMPLES OF MYRMECOIDY FROM CUBA

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